C. Fornari; M. Ferrario; C. Menni; R. Sega; R. Facchetti; G. C. Cesana. Biological consequences of stress: conflicting findings on the association between job strain and blood pressure. S. 1717–1726.

The primary objective is to verify the relation between job strain and clinic blood pressure in a working population from the Milan municipality (1909 men, 3786 women) enrolled from 1992 to 1996. Job strain was investigated through the Karasek model. Clinic blood pressure was evaluated using standard procedures from the MONICA project. The association between the two was calculated controlling for age, education, smoking, body mass index, total and high-density lipoprotein (HDL) cholesterol. Significantly, associations were found for systolic blood pressure in men and for both systolic and diastolic blood pressure in women. However, these results do not reflect biological plausibility. The relationship between job strain and blood pressure is an unfinished business: sample characteristics and measurement methods should be carefully considered.

- **Keywords**: Job strain; Blood pressure; Public administration

E. Occhipinti; D. Colombini. Updating reference values and predictive models of the OCRA method in the risk assessment of work-related musculoskeletal disorders of the upper limbs. S. 1727–1739.

A database has been established combining existing data for 23 groups of workers with different level of exposure to repetitive movements of the upper limbs. For all groups, data were available regarding an exposure index (OCcupational Repetitive Actions - OCRA index) and clinically determined UL-WMSSDs outcomes (PA = Prevalence of workers affected by one or more UL-WMSSDs; PC = Prevalence of single diagnosed cases of an UL-WMSSD). Using these data, new critical values of the OCRA index have been estimated for discriminating different exposure levels (green, yellow, red areas) and new forecasting models of expected PA and PC in exposed populations based on OCRA exposure indexes. The new critical values of the OCRA index were estimated by an original approach in which data for the effect variable (PA) in a reference population not exposed to the relevant risks are combined with the regression function between OCRA and PA. The best simple regression functions between OCRA exposure indexes and health outcomes variables (PA; PC) were researched to obtain forecasting models of effects starting from exposure. Discussion of the results obtained considers their intrinsic limitations, as they are based on prevalence studies, as well as providing
recommendations and cautions in the use of the proposed classification system and forecasting models when the OCRA method is applied.

- **Keywords:** Repetitive movements; UL-WMSDs; Risk assessment; Exposure index

**D. Roman-Liu. Repetitive task indicator as a tool for assessment of upper limb musculoskeletal load induced by repetitive task. S. 1740–1760.**

A unified repetitive task indicator (RTI) has been proposed, characterizing the upper limb load resulting from repetitive work. Within RTI, the work task is described using parameters which refer to the duration of particular sequences of the work cycle and force exerted, taking into account the posture of the upper limb. On the basis of theoretical and experimental studies, undertaken by the author and on the basis of results of experimental studies conducted in other international research laboratories, available in the literature, an analysis was conducted with the aim of developing and verifying the RTI. A comparison of the RTI with indicators of internal load was performed for eight published study cases. The experimental study cases used for verification purposes were conducted for various variants of load (various types and levels of the external force and duration of cycle periods) and for various physiological indicators of internal load. Strong correlations between RTI and indicators of internal load expressed by the unified indicator (IL), showed considerable credibility of the RTI. Results of the verification are noteworthy, given the wide range of cases examined, differing in terms of the conditions under which they were done, the population examined and internal load indicators used. Thus, this analysis indicates that the proposed RTI reflects well the upper limb load occurring as a result of performing repetitive work.

- **Keywords:** Upper limb; Fatigue; Repetitive task; Indicator of upper limb load

**T. R. Waters; M. -L. Lu; E. Occhipinti. New procedure for assessing sequential manual lifting jobs using the revised NIOSH lifting equation. S. 1761–1770.**

A sequential manual lifting job is defined as a job where workers rotate between a series of manual lifting rotation slots or elements at specified time intervals during the course of a work shift. The original NIOSH lifting equation lacked a method for assessing the physical demands of these types of jobs. This paper presents the sequential lifting index (SLI), a new conceptual method for assessing the physical demands for sequential manual lifting jobs. The new method is similar to the composite lifting index (CLI) method that was provided by NIOSH for assessing multi-task jobs. The SLI method expands upon the methods originally provided by NIOSH by providing a simple method for estimating the relative magnitude of physical stress for sequential manual lifting jobs. It should also be useful in assisting safety and health specialists to prioritize or rank hazardous jobs within a plant.

- **Keywords:** Manual lifting; Lifting index; Job rotation; Sequential exposure

**A. Genaidy; W. Karwowski; A. A-Rehim. The work compatibility improvement framework: preliminary findings of a case study for defining and measuring the human-at-work systém. S. 1771–1808.**

Although researchers traditionally examined the 'risk' characteristics of work settings in health studies, few work models, such as the 'demand-control' and 'motivation-hygiene theory', advocated the study of the positive and the negative aspects of work for the ultimate improvement of work performance. The objectives of the current study were: (a) to examine the positive and negative characteristics of work in the machining department in a small manufacturing plant in the Midwest USA, and, (b) to report the prevalence of musculoskeletal and stress outcomes. A focus group consisting of worker experts from the different job categories in the machining department confirmed the
management’s concerns. Accordingly, 56 male and female workers, employed in three shifts, were surveyed on the demand/energizer profiles of work characteristics and self-reported musculoskeletal/stress symptoms. On average, one-fourth to one-third of the workers reported 'high' demand, and over 50% of the workers documented 'low' energizers for certain work domains/sub-domains, such as 'physical task content'/organizational work domains and 'upper body postural loading'/time organization work sub-domains. The prevalence of workers who reported 'high' musculoskeletal/stress disorder cases, was in the range of 25-35% and was consistent with the results of 'high' demands and 'low' energizers. The results of this case study confirm the importance of adopting a comprehensive view for work improvement and sustainable growth opportunities. It is paramount to consider the negative and positive aspects of work characteristics to ensure optimum organizational performance. The Work Compatibility Improvement Framework, proposed in the reported research, is an important endeavor toward the ultimate improvement and sustainable growth of human and organizational performance.

- **Keywords:** Human-at work; System compatibility; Work environment; Job design


Standards organizations have given considerable attention to the problem of work-related musculoskeletal disorders. The publication of international standards for evaluating working postures and movements, ISO 11226 in 2000 and EN 1005-4 in 2005, may be considered as a support for those involved in preventing and controlling these disorders. The first one is a tool for evaluation of existing work situations, whereas the latter one is a tool for evaluation during a design/engineering process. Key publications and considerations that led to the content of the standards are presented, followed by examples of application.

- **Keywords:** Posture; Movement; Risk assessment; Evaluation

**M. Hagberg; R. Vilhemsson; E. Wigaeus Tornqvist; A. Toomingas. Incidence of self-reported reduced productivity owing to musculoskeletal symptoms: association with workplace and individual factors among computer users. S. 1820–1834.**

The aim of the present study was to assess the incidence and identify possible risk factors for self-reported reduced productivity owing to musculoskeletal symptoms among computer users. **Design:** a cohort study with a baseline questionnaire and monthly follow ups during 10 months. **Methods:** the study base consisted of 1283 computer users, 636 men and 896 women. Ergonomists observed workstation characteristics before entering the cohort. Cases were defined as subjects reporting reduced productivity or reporting being on sick leave owing to musculoskeletal symptoms. **Results:** women had approximately two times the incidence of self-reported reduced productivity owing to symptoms in the neck, shoulder and in the forearm/hand than men. There was no difference in gender for the incidence of self-reported reduced productivity owing to back symptoms. Working overtime and job demands were risk factors for self-reported reduced productivity owing to neck and back symptoms. Physical exercise fewer than 8 times the last month was a risk factor for self-reported reduced productivity owing to neck, shoulder and forearm/hand symptoms. Computer mouse use for more than 0.5 h/day was a risk factor for self-reported reduced productivity owing to shoulder and forearm/hand symptoms. **Conclusions:** risk factors for self-reported reduced productivity owing to musculoskeletal symptoms included lifestyle factors, such as overweight and low physical exercise, occupational factors, such as overtime, job demands and computer mouse operating time.
A field study was conducted to investigate spinal kinematics and loading in the nursing profession using objective and subjective measurements of selected nursing tasks observed in a hospital setting. Spinal loading was estimated using trunk motion dynamics measured by the lumbar motion monitor (LMM) and lower back compressive and shear forces were estimated using the three-dimensional (3D) Static Strength Prediction Program. Subjective measures included the rate of perceived physical effort and the perceived risk of low back pain. A multiple logistic regression model, reported in the literature for predicting low back injury based on defined risk groups, was tested. The study results concluded that the major risk factors for low back injury in nurses were the weight of patients handled, trunk moment, and trunk axial rotation. The activities that required long time exposure to awkward postures were perceived by nurses as a high physical effort. This study also concluded that self-reported perceived exertion could be used as a tool to identify nursing activities with a high risk of low-back injury.

**Keywords:** Nursing; Spine; Kinematics; Compressive and shear force; Perceived risk of musculoskeletal injury

**K. Gielo-Perczak; S. Matz. The area of glenoid asymmetry identified as important contributor to shoulder strength during pushing and pulling in the coronal plane. S. 1856–1870.**

The geometrical dimensions of the bones that make up the glenohumeral joint could be a key factor in strength predictability. Understanding the mechanical influence of these dimensions (individually or in combination) on shoulder strength could help explain the mechanism of musculoskeletal disorders. The following study shows how a recently discovered geometric parameter, the area of glenoid asymmetry (AGA), is a good indicator of shoulder strength. A comprehensive study was conducted to test whether glenohumeral geometry, as measured through MRI scans, is correlated with upper arm strength. The isometric shoulder strength of 12 subjects during one-handed arm abduction and adduction in the coronal plane, in a range from 5° to 30°, was correlated with the geometries of their glenoid fossae. All subjects were stronger during adduction than abduction for all arm positions. The results revealed a high correlation in the coronal plane between the AGA and mean maximum force and mean maximum moment when an arm was abducted and adducted in a range from 5° to 30° (0.80, \( p < 0.01 \) and 0.69, \( p < 0.05 \), respectively during abduction and 0.61, \( p < 0.04 \) and 0.61, \( p < 0.04 \), respectively during adduction). This investigation revealed the repercussion of individual glenoid geometry on the maximum acceptable load applied to the hand during arm abduction and adduction in a coronal plane.

**Keywords:** Glenohumeral joint; Abduction; Adduction; Glenoid fossa; Articulating surfaces

**K. Landau; H. Meschke; R. Brauchler; J. Kiesel; J. Knoerzer. Ergonomics diagnosis components in rehabilitation: statistical evaluation of an assessment instrument. S. 1871–1896.**

The current paper examines an assessment instrument used for combined medical and occupational rehabilitation (MOR) in a group of German hospitals. Patients with a history of musculo-skeletal disease make up a significant proportion of those undergoing rehabilitation. Scale and factor structures, discriminant factors and clustering procedures
used in the Bavaria rehabilitation patient assessment method (BRPAM) are investigated in a cross-sectional study involving a sample of 800 patients. Although the results reveal good correlation between differences in the job demand/patient capability profiles and the typical stresses to which the relevant occupation is exposed, analyses also indicate that several factors and items are unstable. According to subjective assessment by the patients, the therapeutic objectives are fully attained in some 80% of cases. Discrepancies between job demands and patient capability revealed by the BRPAM yield pointers to choice of therapy and its chances of success, but these need to be examined in greater detail in long-term studies.

- **Keywords:** Ergonomic assessment; Combined medical and occupational rehabilitation (MOR); Demand/capability profile; Validity


This study sought to collect evidence on age and workability in fire fighters, using systematic international literature searches, interviews, and secondary analyses from Dutch fire fighter studies. Recent decades have witnessed growing demands on fire fighters, who face peak task demands during duty. Older Dutch fire fighters experience greater emotional and mental demands than their younger colleagues. Huge inter-individual variation emerged in task performance with over six-fold differences in time-on-tasks and the percentage heart rate reserve between and within age groups. However, no age-effect was observed in lifting capacity during simulations. Compared to their youngest colleagues, older Dutch fire fighters face a six-fold increase in the risk of health complaints. The international literature lacks psychological age effects studies. Semi-functional tests, (e.g. exercise stress testing or push-ups) do not predict workability. Regular screening of fire fighters, using multi-modal functional tests that closely simulate real job activities, is recommended.

- **Keywords:** Ageing; Fitness for duty; Fire fighters


The current paper reports the main results of several studies carried out on Italian workers using the work ability index as a complementary tool for workers' periodical health surveillance. The work ability index shows a general decreasing trend over the years, but it changes differently according to working conditions and personal health status. In jobs with higher mental involvement and autonomy, but lower physical constraint, it remains quite constant and high over the years, while it significantly decreases with a steeper trend the higher the physical work load and the lower the job control are. Sex and working hours appear to act concurrently in influencing work ability, particularly in association with more physically demanding jobs. It is therefore necessary to adopt flexible interventions, able to give ageing shift workers a proper support for maintaining a satisfactory work ability, by means of actions addressed both to work organization and psycho-physical conditions.

- **Keywords:** Ageing; Working hours; Work ability; Shift work; Health care workers

G. Pravettoni; M. Cropley; S. N. Leotta; S. Bagnar. The differential role of mental rumination among industrial and knowledge workers. S. 1931–1940.

The nature of work has been changing. It is becoming more and more uncertain, complex, cognitively demanding, disperse in space and in time, and diverse for the people involved. It requires diffuse decision making and responsibility. Knowledge and creative work, instead of industrial, currently occupies the majority of workforce. A recent NIOSH report (2002) claims that the changing nature of work asks for new
research, tools and methods for evaluating the impact of its transformations on workers’ health and safety. Following this claim, the current paper investigates the process of recovery from fatigue. Since it is known that the quality of recovery may be highly impoverished by the presence of persisting and pervasive mental activity, namely, by mental rumination, the investigation focuses on the possible differential characteristics of rumination among industrial and knowledge workers. The results from a field study shows evidence that industrial and knowledge workers are differentially affected by rumination. It is suggested that rumination can be a promising early indicator of stress in knowledge occupations.

- **Keywords:** Knowledge work; Routine work; Stress; Rumination


The current paper considers a new perspective in research and designing which ergonomics is facing at present. It is related to a spectacular progress in neuroscience. Implementing both the latest research results concerning the functioning of neural systems and new non-invasive techniques of brain examination in ergonomics constitutes a serious challenge and, simultaneously, offers unprecedented opportunities for the discipline. This paper posits that assuming a neuroergonomic perspective in ergonomic research and designing leads to a new quality. Knowledge concerning neural structures and mechanisms responsible for behavioural, cognitive and emotional activity will force out the knowledge based on psychological constructs from the field of ergonomics. We are questioning the perception of neuroergonomics as a discipline which resorts to psychological constructs. We are postulating rejecting such constructs in neuroergonomic field as too general in their formulation of certain regularities and failing to ensure satisfying accuracy of measurement.

- **Keywords:** Neuroergonomics; Psychological constructs; Neuroscience; Research and designing in ergonomics


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