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Ergonomic intervention programs in different economic sectors: a review article

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Abstract. Unlimited number of hazards can be found in almost every workplace increasingly causing work-related diseases (WRDs) and injuries among workers. In work environment there are various risk factors: physiological, physical or psychological. An awkward and static postures, repetitive movements, high work pace, non-ergonomic tools and poorly organized workstations are most likely causing musculoskeletal disorders. As well inconvenient room temperature, noise, vibration and poor lighting conditions can conduce to additional work discomfort, mental stress, fatigue, injury, or trauma among employees. Ergonomic interventions are coming more popular. Many organizations are trying to find best solutions to avoid musculoskeletal disorders (MSD). The aim of this paper is to describe different ergonomic interventions focused on diminishing of musculoskeletal discomfort and MSDs among workers. This paper gives overview about the most common and effective ergonomic interventions which really have worked in practice. For this research were used three different databases EBSCO, Science Direct and Mendeley. The selection of publications passed three phases of systematic search of literature: the first elimination consist of keywords 'ergonomics, intervention' and year of publication. In the second phase was added a keyword 'work' and in the third phase were eliminated repeated and literature review publications and as well publications which had little sample size or the exploration was not covered with real interventions. The publications (n = 209) of ergonomic interventions carried out in the past five years 2010–2015 were analyzed. Wide spectrum of different ergonomic interventions was found in several economic sectors, whereas the most effective ones were related to well-known ergonomics methods, workstation adjustment, training and exercises.

Key words: ergonomic interventions, ergonomically designed workplaces, musculoskeletal disorders.

INTRODUCTION

Musculoskeletal disorders are most common occupational diseases throughout the industrialized world, in Europe as well in Estonia (Eurostat, 2009; Health Board, 2016). Explorations have shown that feeling pain or discomfort in different parts of musculoskeletal systems is the main reason for unproductive work or even sick leave. Musculoskeletal disorders are still the most often reported occupational diseases causing the lost working hours, increasing economic costs for enterprises (Noroozi et al., 2015).

Work-related musculoskeletal disorders are widespread among every occupation and costly to the health care system (Fabrizio, 2009). There is evidence that inappropriate design of workplaces and work processes contributes significantly to the development

and chronicity of common musculoskeletal disorders (Rivilis et al., 2008). Musculoskeletal disorders occur due to many aspects like awkward working posture and poor workstation design. Even office workers in prolonged sitting position can´t mention the psychological risk factors. Also prolong standing leads to physiological discomfort, fatigue and health problems. In agricultural industry workers are required to perform physically demanding jobs that put them at significant risk for developing work-related musculoskeletal disorders. Workers among manufacturing industry are not left untouched by musculoskeletal diseases. Material handling and lifting tasks have to make properly to avoid any disorders, discomforts or injuries. In electronic industry can be found factors for example static postures, work methodology, condition of work environment and not so well designed workplaces which direct to musculoskeletal disorders.

The main focus of health and safety issues is related to upper or lower limb pain. Upper limb regions are neck, shoulders and arms. Lower limb regions are back, hips, knees, ankles and feet. Musculoskeletal disorders can affect the muscles, bones and joints. Most common diagnoses are tendinitis, carpal tunnel syndrome, osteoarthritis, rheumatoid arthritis, fibromyalgia and bone fractures. Discomfort in any body region could lead further to musculoskeletal disorder. This is the reason why is very important to focus on discomfort even if this is not causing a lot of afflictions yet.

Furthermore, evidence that the risk or protective factor precedes the disorder is an important indication that the factor has at least a potential role in causation. Also, there may be a dosage effect, what means the stronger the risk factor, the more disorders (Mrazek & Haggerty, 1994).

To achieve better health in easiest and inexpensive way there comes to the picture ergonomics and ergonomics knowledges. Ergonomics is defined by the International Ergonomics Association as 'the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and profession that applies theoretical principles, data and methods to design in order to optimize human being and overall system' (International Ergonomics Association, 2000).

To change something by using knowledge of ergonomics are called ergonomics interventions. Ergonomic interventions have become more prominent and are one of many proposed interventions for treatment and prevention of work-related musculoskeletal disorders. The effectiveness of ergonomic principles for preventing and reducing musculoskeletal disorders has led to a recent boom in intervention research (Dempsey, 2007).

Ergonomic interventions have grown as the most popular research method and important part of work place safety and health strategy in the last decade. Prevention is the basic principle of occupational health and safety (OHS) culture to minimize occupational risks and diminish occupational accidents and diseases. Ergonomic intervention is a part of OHS prevention programs. Ergonomic intervention is the use of ergonomics in preventing disability in injured workers and classified as individual, organizational, physical and psychosocial ergonomic interventions (Driessen et al., 2011). An involvement of workers in decision-making, sharing information and rewarding from management to lower levels of organization have seen as participation ergonomics (Institute for Work and Health, 2008). Ergonomic interventions can be divided to: individual ergonomic intervention (IEI), physical ergonomics intervention (PEI), organizational ergonomic intervention (OEI) and combined ergonomic

interventions (CEI). A number of OEI studies have proved that the effectiveness of an organization is closely related to a human performance at work, skills and health. The owners of companies have to know that ergonomics intervention may cost in the beginning, but will compensate in the end.

There are a variety of actions that have been applied in the workplace for eliminating or reducing the occurrence of occupational musculoskeletal disorders among employees. One rapid way to prevent musculoskeletal disorders is to expand ergonomic knowledges and use interventions among employees. The purpose of any ergonomic intervention is to improve worker comfort. Till today scientists have made lot of work to figure out the best ergonomic interventions. They have analyzed their impact to health and through this the impact to productivity. Any ergonomic intervention will be preceded by setting up strategies expected to lead to the intended succeed change.

Physical ergonomic interventions are dealing with most important physiological risk factors as lifting loads, physically heavy work, awkward postures, repetitive movements, frequent bending or twisting of elbow, wrist and fingers (Driessen et al., 2011). Adapting of physical loads not always reduce pain prevalence, intensity and/or duration, so it must combine with physical exercises It has been evaluated as an effective preventative intervention method for reducing MSDs, especially in the neck and lower back (Linton & Tulder, 2001).

The goal of psychosocial interventions is to reduce distress and impact of stressful events, minimize symptoms and decrease disability, to improve coping skills and quality of life. Evidence-based psychosocial interventions in use more often in mental health care for measurement whether the patients are receiving high-quality care. Psychosocial interventions apply a positive effect on quality of life and positive mental health but not always with successful outcomes (Forsman et al., 2011). Three types of psychosocial intervention approaches have used in practice: 1) universal prevention (mental health promotion through general health education) targeting healthy older adults in active aging; 2) selective prevention, targeting older age groups not suffering from mental disorders and 3) indicated prevention directed at people with sub-clinical symptoms of depression (World Health Organization, 2004).

The aim of this study is to give a critical analysis of the peer-reviewed literature, to provide a comprehensive summary of effectiveness of ergonomic interventions in improving workers health and productivity.

MATERIALS AND METHODS

Researches about ergonomics interventions are very young field, but the past decade has brought encouraging progress. In spite of huge amount of research have been published, lack of systematic information about methodology of ergonomic interventions has seen yet. For this experiment were used EBSCO, Science Direct and Mendeley databases. In a systematic search of combined keywords ergonomic and intervention it has found together 1,631 articles. Most publications were found in Science Direct, then EBSCO and Mendeley databases. The title and content of article were decisive and main criteria. The general principles for selecting articles were effective, successfully implemented and be well-documented ergonomic interventions.

A framework of eliminating the publications for critical analysis contained of three phases. In first phase were culled out articles, which were not written in English and

older than 2010 year published. Eighty four publications of 1,631 were left out because these were in Chinese, French, Persian, Spanish and Portuguese. The first elimination of first phase on flowchart below (Fig. 1) shows, how many articles survived after reading English abstract and language control. After publication year control, altogether in the foreground remained 604 articles.

The first elimination of first phase on graph shows how many articles where survived after language control and second one shows how many articles after publication year control. The amount of articles after first phase is still very big. Altogether in the foreground remained 604 articles.

In the second phase special keyword 'work' was included and searched from titles, abstracts and main text. In the end of second phase left on the surface 209 articles. Analyzed were 209 publications all over the world in various fields over the past years. Abstracts from all 209 articles were read.

In the third phase has not taken account of articles, which were repeated in databases, which described review of literature, where participants were less than 50 and if these articles were out of subject. Sample size was selected to 50 persons, because larger number will give better overview of impact of intervention. If the intervention was about tool design, then sample size did not matter. Five articles of 91 described design or change of tool intervention. The first elimination of third phase on graph shows how many articles where survived repeating control, second one shows how many articles after review of literature control, third one after sample size control and forth off the subject control. After the eliminations and systematic research remained 91 publications (Fig. 1).

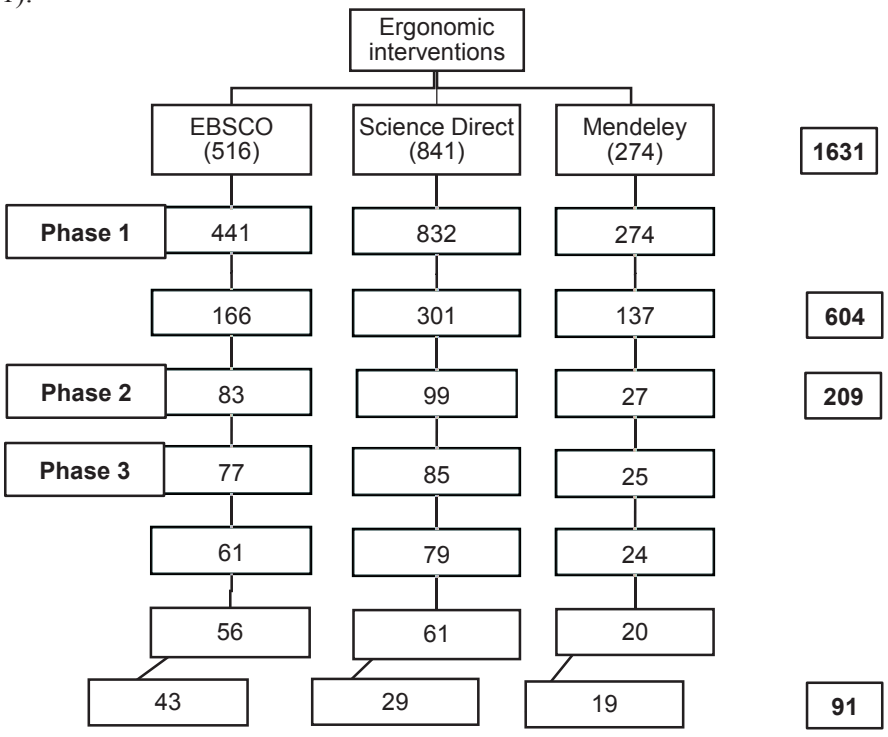

Figure 1. The flowchart of eliminating articles about ergonomic interventions.

In this observed research on ergonomics interventions the area of dissected occupational area was very wide: office workers, administrators, nurses, students, construction workers, carpet weavers, goldsmiths, postmen, school teachers, dentists, sewing machine operators, material handling and workers in industrial or agricultural occupation.

Ergonomic interventions have become a popular way to describe the improvements at workplace and it really has ambivalent understanding. Some publications have named ergonomic intervention as a questionnaire studies that described just results giving overview of current situation. These articles were excluded from this analysis. The studies about ergonomic interventions with positive results were taken under the analysis. The authors concentrated especially on these publications which showed statistically significant difference between the experimental and control group or achieved considerable better health or increased productivity after the intervention.

Ergonomic interventions by the activities were classified as engineering, administrative and behavioral or personal ones. Engineering changes would modify the work station or work environment. Administrative interventions often change the duties of workers by job assignment or rotation or work-rest schedules. Personal interventions mostly implemented changes in work process. There have been used training methods to improve knowledge and physical exercises to diminish prevalence of MSDs among employees.

The regions where the ergonomic intervention projects have carried out were: Iran, United States of America, China and India. Also there were articles from Brazil, United Kingdom, Thailand, Hong Kong, Sweden, Kenya, Canada, Egypt, Netherlands, Indonesia, France and Latvia.

However, in some publications the effectiveness of interventions was unclear. Because of methodological and organizational reasons and poor scientific quality these studies were not accepted.

For better understanding the articles, following questions were considered:

- Which type of interventions have used?
- To whom the intervention was made?
- What exactly have been done?
- Does it have results?
- How was it evaluated?
- Is this result comparable to other studies at this field?

The search strategy was targeted on 91 potential articles on ergonomic interventions, and had calculable scientific value. The different occupations were under the analysis, for instance industry workers, teachers, nurses, household workers, computer workers, dentists or manual material handling operators. Each research concentrates on their field. The main aim was to find out best ergonomics interventions which really have been worked in practice, irrespective of on whom these were implemented.

RESULTS AND DISCUSSION

Wide spectrum of different ergonomics interventions were found in this research. Most of the changes focused on well-known ergonomics methods like:

Rapid Upper Limb Assessment (RULA);

Rapid Entire Body Assessment (REBA);
Ovako Working posture Assessment System (OWAS);
The Quick Exposure Check (QEC);
Strain Index (SI);
Rapid Office Strain Assessment (ROSA);
Occupational Repetitive Actions (OCRA);
National Institute for Occupational Safety and Health Lifting Equation (NLE);
Association of periOperative Registered Nurses (AORN) Ergonomic Tool.

Work processes and tools´ design were the common target topics of ergonomic interventions. The latter involved situations when it was started to utilize new instrument or some modification with old ones or totally new tool was designed or change in work processes, work methods or techniques was implemented. Special auxiliaries categorized as well in this category. All equipment interventions were included in this distribution, too. Usually the questionnaires were used to determine the prevalence of musculoskeletal disorders for pre- and post-intervention period. The Nordic Musculoskeletal Disorders Questionnaire was used most often.

In the observed studies the next questionnaires were used:
Nordic Musculoskeletal Disorders Questionnaire (NMQ);
Copenhagen Psychosocial Questionnaire (COPSOQ);
Corlett and Bishop's body part discomfort scale (BPD);
Work-related upper extremity musculoskeletal symptoms (WUEMSS);
Dutch Musculoskeletal Questionnaire (DMQ);
Ergonomic Questionnaire (EQ).

Workstation improvement and knowledge training were the interventions on the fourth place. Workstation improvements interventions considered the ergonomically well designed workstations, where workplace adjustment and improvement of workstation were under observation. Some analysis used Quick Exposure Check (QEC) to get overview of workplace. Assessment of body posture and anthropometric measurements belonged to this intervention methodology. Training and educational interventions have used by eleven researches and have shown to reduce MSDs among employees. Many publications have concentrated on risk analysis and improvements of work environment. Work environment observations and measurements, ergonomic inspection, analysis, survey, inclusion of ergonomist or occupational therapist and ergonomic counselling were the most often used methods. Biomechanical analysis of repetitive movements was used by some researches. There were also interventions where material handling tasks, physical exercises and health care procedures were used. The categorized ergonomic intervention methods used in the present literature review are shown in the Fig. 2.

The combined interventions were under the analysis as well. A systematic approach to intervention appeared to be more useful.

To reduce or prevent MSDs in one engineering company a professional guidance of occupational therapist or physical therapist was used to control the workstations and this intervention program was successful (Goodman et al., 2005).

Great illustration of tool based intervention was carried out among 105 male assembly workers of a semiconductor in Tehran province. Implemented was a new tool to minimize musculoskeletal discomfort. They started to use magnificent loupes. The standardized Nordic Musculoskeletal Questionnaire (NMQ) was used to determine the

prevalence of MSDs. To evaluate body discomfort before and after the intervention Corlett and Bishop's body part discomfort scale (BPD) was used. After ergonomic intervention significant decrease of discomfort was observed in neck, shoulder, upper arm, elbows, lower arm, lower back and whole body discomfort (Aghilinejad et al., 2016).

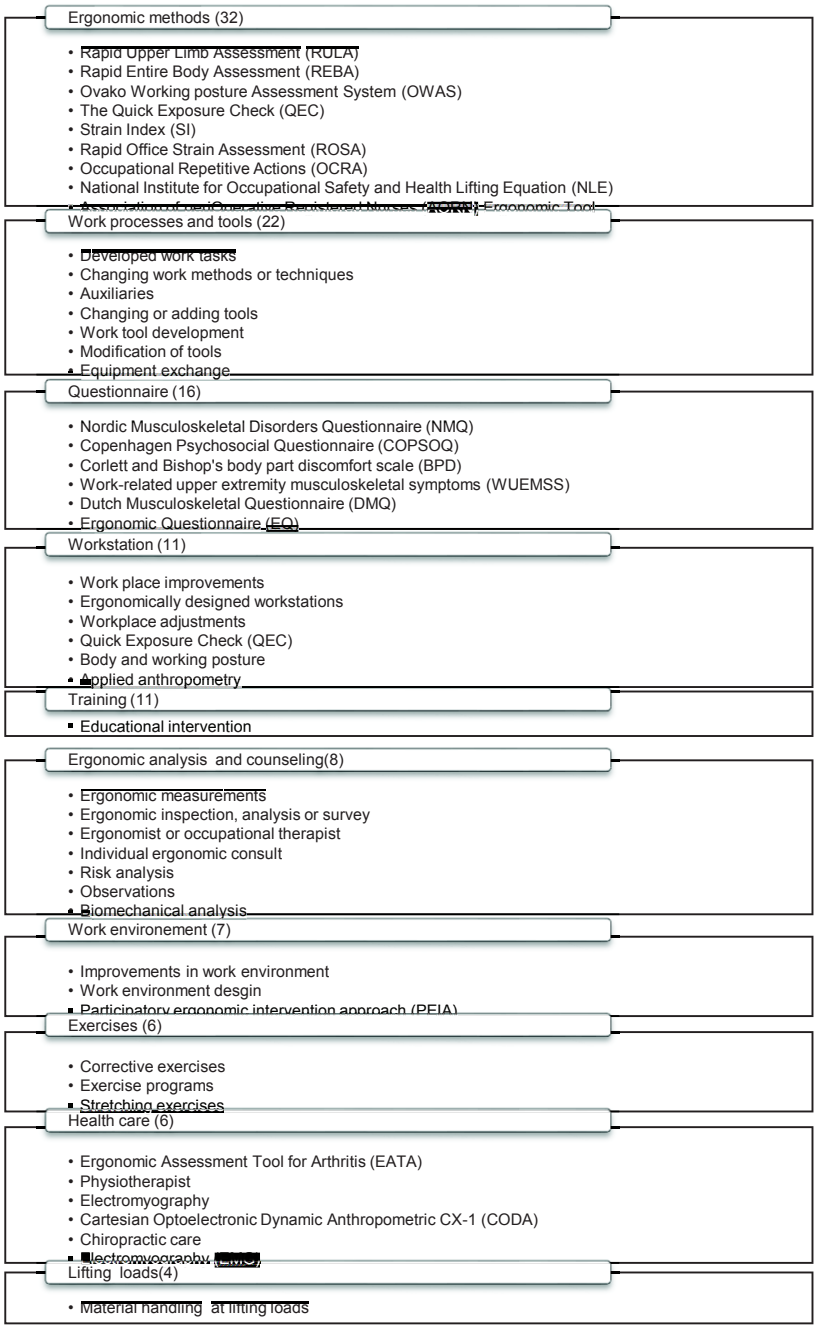

Figure 2. Categorized ergonomic intervention methods.

Educational training (pamphlet, lecture and workshop) in the automobile factory in Iran was implemented in three different ways. Workshop as an ergonomic training method was effective, decreasing the prevalence of neck and shoulders complaints among factory workers (Aghilinejad et al., 2015).

That body posture and workstation layout interventions are successful it has been described among 400 computer workers in United States. After baseline assessment, those in the intervention group participated in a multicomponent ergonomic intervention program including a comprehensive ergonomic training consisting of two interactive sessions, the ergonomic training brochure was divided, and workplace visits with workstation adjustments. Follow-up assessment after 6 months intervention showed significant decrease of work-related upper extremity musculoskeletal symptoms (WUEMSS) decreased significantly in the intervention group compared with the control group. Physical and mental health-related quality of life improved significantly compared to the reference group (Esmaeilzadeh et al., 2014).

It is well-known that poor lighting conditions cause eyestrain and in long perspective vision impairment and decrease of work productivity. Hemphäläa & Eklundb (2012) demonstrated that new lighting system improved the illuminance and light distribution in mail sorting facilities in Sweden. Also, the new acquired personal spectacles diminished eyestrain among the postal workers. Use of the specific type of sorting spectacles among those, who already used progressive lenses privately, improved head postures, alleviating muscular strain and decreasing risk of MSDs. (Hemphäläa & Eklundb, 2012).

Fourteen effective ergonomic interventions are described in the Table 1. There are six of them carried out in industries, four among health care workers and four among officials, office workers and teachers. The articles are categorized yearly.

As we can see in the Table 1, the combined interventions had positive effect among fifty nurses in Hong Kong. The 8-week intervention program consisted of ergonomic training, daily exercise program, equipment modification, computer workstation assessment and typing training. Positive results were found in decreased symptom scores (Szeto et al., 2013).

The combined ergonomic intervention (training, software and sport exercises) was carried out among the gas company staff in Iran and the used activities were compared. The Nordic Musculoskeletal Questionnaire (NMQ) was used for measurement of prevalence of MSDs and rapid upper limb assessment (RULA) for assessment of upper limb posture risks. The results of used activities were compared using McNemar test, t-test, and Chi-square test. Significant decrease of musculoskeletal symptoms was detected in the group after they received the training. McNemar test showed that pain intensity in the lower back, neck, knee, and wrist was significant ($p < 0.05$). The results obtained from the RULA method for evaluation of posture showed an average 25 points decrease in the right side of the body and 20 points decrease in the left side of the body in the group subjected to training. Based on t-test, the decrease was significant. The study demonstrated that majority of the participants accepted interventions and seeking the ergonomic improvements at the workplace. Overall, the findings show that that all three interventions training, chair adjustment, and arrangement in workplace could decrease MSDs and most effectively in the training group (Habibi & Soury, 2015).

Table 1. Successful ergonomic interventions in different fields of economic sectors (Abbreviations: IEI – individual ergonomic intervention; PEI – physical ergonomics intervention; OEI – organizational ergonomic intervention; CEI – combined ergonomic interventions)

Authors	Year	Location	Subjects	Intervention type	Control group	Dependent measures	Statistics	Results	Comments
Aghilinejad, M., Azar, N., Ghasemi, M., Dehghan, N. & Kabir-Mokamelkhah, E.	2016	Iran	Assembly workers N = 105	IEI: Using a magnifying loupes	Pre- and post-intervention results	NMQ (BPD)	$p < 0.05$	Decreased discomfort in neck, shoulder, upper arm, elbows, lower arm, lower back	Decreased whole body discomfort. There was no reference group, but results were good
Abdollahzade, F., Mohammadi, F., Dianat, I., Asghari, E., Asghari-Jafarabadi, M. & Sokhanvar, Z.	2016	Iran	Nurses N = 147	PEI: Working postures, educational programs.	No	REBA	Exercise ($p = 0.048$), Experience ($p = 0.003$), Shifts num. ($p = 0.006$)	Working posture can consequently lead to promotion of health and well-being	No reference group, but effective results
Habibi, E. & Soury, S.	2015	Iran	Industry workers N = 75	PEI: Training, exercise, and software	No	NMQ RULA	McNemar test: pain in low back, neck, knee, and wrist $p < 0.05$	Training, chair adjustment, and arrangement in workplace could decrease musculoskeletal disorders	No reference group, but effective results
Ghanbary, A., Habibi, E. & Darbandy, A.A.	2015	Iran	Household workers N = 100	CEI: Posture analysis Training	No	NMQ OWAS	Work experience ($p < 0.01$)	The prevalence of MSDs had significant correlation between work experience	Worker´s work experience has influence to disorders

Table 1 continuing

Aghilinejad, M., Kabir-Mokamelkhah, E., Labbafinejad, Y., Bahrami-Ahmadi, A. & Hosseini, H.	2015	Iran	Automobile factory workers N = 503	OEI: Ergonomic training (pamphlet, lecture, workshop)	Yes	NMQ Chi-square and Mann-Whitney tests	Recent week ($p = 0.002$) year ($p = 0.02$)	Workshop helped to decrease the prevalence of neck and shoulders complaints	Large amount and three different training interventions.
Esmaeilzadeh, S., Ozcan, E. & Capan, N.	2014	United States of America	Computer workers N = 400	CEI: Body posture and workstation layouts	Yes	Ergonomic Questionnaire WUEMSS	Body posture ($p < 0.001$) workstation layout ($p = 0.002$) physical ($p < 0.001$), mental $p = 0.035$)	WUEMSS decreased significantly	Large amount and combined interventions.
Jian, S., Pengying, Y., Liping, L., Fengying, L. & Sheng, W.	2014	China	School teachers N = 350	PEI: Training	Pre- and post-questionnaires	DMQ NMQ	$p < 0.001$	The awareness rate, attitude and health behavior improved	Interventions had positive effect.
Kumar, B.A. & Begum, S.H.	2014	India	A pedal operated maize sheller	IEI: Designed tool	Yes (manually operating)	Collection efficiency through put rate	150 kg h^{-1}	This tool help to 5.5 times more than hand operated sheller	Good design and good analysis
Szeto, G.P., Wong, T.K., Law, R.K., Lee, E.W., Lau, T., So, B.C. & Law, S.W.	2013	Hong Kong	Nurses N = 50	CEI: Training Exercises Work processes and tools Workstation	Yes	NMQ NPQ CODI DASH	$p < 0.05$	Positive results in decreased symptom scores	Combined interventions showed posi-tive effect

Table 1 continuing

Rafeemanesh, E., Jafari, Z., Kashani, F. & Rahimpour, F.	2013	Iran	Dentists N = 58	PEI: Improvement of job postures	No	NMQ REBA	Prevalence of MSD 75.9% for the neck, 58.6% for the shoulders, 56.9% for the upper back, 48.3% for the lower back and 44.8% for the wrist	Overview of musculoskeletal disorders among dentist	Concluded that work postures of dentists need to be improved
Hemphäläa, H. & Eklundb, J.	2012	Sweden	Workers in mail sorting N = 75	OEI: Work environment and auxiliaries	Yes	EMG	Eyestrain. 44% -> 32%	Eyestrain decreased and productivity increased	Better work conditions improve health and productivity
Bernardes, J.M., Wanderck, C. & Moro, A.R.	2012	Brazil	Manual material handling operators N = 500	OEI: Ergonomic analysis rede-signed the assembly line's layout.	No	NIOSH equation	$p < 0.05$	Lift index > 1.0	Low back pain was totally eliminated
Ma, C., Szeto, G.P., Yan, T., Wu, S., Lin, C. & Li, L.	2011	China	Computer workers N = 72	PEI: Training	Yes N = 3	EMG	$p < 0.05$ Cervical erector spinae muscle, bila-teral upper trapezius	Pain reduced significantly more in the biofeedback group	Training had positive effect
Nader, R., Effat, B. & Fadya, R.	2010	Iran	Industry workers N = 91	PEI: 8-week corrective exercise program	No	NMQ	($p < 0.05$); low back (26.3 %), shoulder (18.9%) knee (17%)	Exercise program was effective to decrease work-related disorders	No reference group, but effective results

Physical activity has good effect on health. Very often corrective exercises have been used for individual ergonomic intervention. The experimental study was carried out among 91 workers in Teheran Loabiran industry. The corrective exercise program consisted of three sessions per week; each session extended 45 to 90 minutes). After the intervention it was concluded that corrective exercise program was effective and it was recommended to decrease risk of prevalence of MSDs among industrial workers (Nader et al., 2010).

Participatory ergonomic intervention was aimed to reduce lower back pain in the dispatch department of a catalogue and e-commerce retail company in Brazil. Based on the findings of the ergonomic analysis the company's own employees redesigned the assembly line's layout. Two job tasks of manual material handling were eliminated and more control over the jobs was given to the employees responsible for moving boxes from the end of the assembly line to pallets on the ground. The results demonstrated that participatory ergonomic interventions were effective – the revised NIOSH equation showed lower risk for lifting-related low back pain (Bernardes et al., 2012).

The study of 147 operating room nurses in Tabriz was conducted to evaluate working postures using a questionnaire and the Rapid Entire Body Assessment (REBA) checklist. The data were analyzed using t-test, Pearson correlation coefficient and analysis of variance (ANOVA) tests for univariate analysis and the linear regression for multivariate analysis. The mean (±SD) of REBA score was 7.7 (±1.9), showing high risk of working postures for nurses. There was significant relationship between daily regular physical exercises ($p = 0.048$), work experience ($p = 0.003$) and number of shifts per month ($p = 0.006$). The findings highlighted the need for ergonomic interventions and educational programs to improve working posture among nurses, promoting health and well-being of this group (Abdollahzade et al., 2016).

Training intervention among computer workers in an outpatient physiotherapy clinics and a local hospital was carried out in China. Activity of muscles 72 computer workers were measured by electromyographic (EMG) method. Post intervention, average pain was reduced significantly more in the biofeedback group than in the other 3 groups not exposed to training. This training intervention maintained for 6 months. Significant post intervention reduction of electric activity in cervical part of *m. erector spinae* and bilaterally in *m. trapezius superior* was measured in the biofeedback group (Ma et al., 2011).

The intervention where muscle activity was measured by using questionnaire before and after the intervention is widely used in the studies. One more of this was made in United States of America in dairy industry. Surface EMG was sampled continuously during the entire work shift while workers performed milking parlor tasks (Roscerance & Douphrate, 2012).

In 2015 was made successful case study, which proved that worker´s age and work experience have influence to inchoative musculoskeletal disorders (Ghanbary et al., 2015). This means if worker have to be long time in not suitable work environment that will increase health issues.

All above mentioned interventions have showed statistically significant reduction of MSDs in all body regions of observed occupations, except one study among 165 call center operators. This one-year prospective study passed four workplace interventions: ergonomics training, trackball and ergonomics training, forearm-support board and ergonomics training and forearm-support board, trackball and ergonomics training. No

any significant changes were found with change in neck–shoulder or left upper-extremity pain after the interventions (Krause et al., 2010).

Majority interventions focused on decreasing shoulder, neck and low back pain. Wrist, ankles, hips, knee and feet regions were less or not used.

Other important results

Often is believed that is too late to make any ergonomic interventions. Reasons are diverse: workers are too old or too sick, not enough time or money. In this systematic research several articles of ergonomic interventions which were applied on people with disabilities have found. These were not taken into account of the further analysis, but still were good examples. For instance an experiment which was carried out among workers who have arthritis is great example. In the total sample (n = 89) contained of 38% with rheumatoid arthritis and 62% with osteoarthritis. The work place ergonomic intervention group reported less arthritis symptoms than the others (Baldwin et al., 2012).

Ergonomic interventions can be used also on people who already have musculoskeletal disorders, named as case studies. In United States of America was in 2010 made experiment with administrative assistant who had work-related lateral epicondylitis. The worker received ergonomic and behavioral interventions to treat her injury that included modification to her work environment and education on modifying behaviors that would decrease stress and excessive work. Results were that client reported decreased headaches with improved lighting and increased tolerance to typing with the addition of a keyboard tray (McCormack, 2010).

The minus of this research is that it was made only with one person, but still had positive effect. Another similar case study was made with 26-year-old woman with right upper-extremity and neck pain. This report again demonstrates the importance of examining the work habits and work-related postures. Providing an ergonomic intervention in concert with traditional physical therapy may be the most beneficial course of treatment (Fabrizio, 2009).

A 41-year-old woman presented with hand weakness and numbness along the medial aspect of her right forearm and the three most medial fingers. Chiropractic treatment consisting of manipulation, soft tissue mobilizations, exercise, and education of workstation ergonomics appeared to reduce the symptoms of ulnar nerve compression symptoms for this patient. Over a series of 11 treatments, her symptoms resolved completely and she was able to perform work tasks without dysfunction (Illes & Johnson, 2013).

People with disabilities may allow ergonomists to develop specific solutions for successful intervention and improve their functional capacity. Being too sick is not the excuse to not implement ergonomic interventions. Even these ergonomic interventions have shown positive effect.

Even young people like school children could have musculoskeletal disorders. Ergonomically design furniture and ergonomic awareness reduce discomfort and pain. In Pakistan among 229 school children in 2nd Grade (age 8 years) and 5th Grade (age 11 years) were implemented ergonomic interventions. Weight of the bag, Rapid Upper Limb Assessment (RULA) score and Ergonomic Quiz were used as main indicator to

analyze the effectiveness of programs to reduce ergonomic risks (Ismail et al., 2010). In consequence the age is also not a factor.

The economic benefits of ergonomic interventions may easily overwhelm the costs because of productivity and quality with improved health. To the allegation that there is not enough money against this there are also objections. There is possible to make calculations before interventions. Cost-benefit analysis (CBA) can help to justify an investment in ergonomics interventions. A predictive CBA model would allow practitioners to present a cost justification to management during the planning stages, but such a model requires reliable estimates of the benefits of ergonomics interventions. Cost-justifying ergonomics interventions prior to implementation may support secure management support for proposed changes (Goggins et al., 2008).

CONCLUSIONS

Very wide spectrum of different ergonomics interventions focused on well-known methods. Work processes and tools are also very common ergonomic interventions. Workstation improvements, trainings, various ergonomic analysis, work environmental modification, exercises or using guidance of physiotherapist were the most effective interventions diminishing risk of MSDs among employees. The questionnaires were most often used to determine the prevalence of MSDs pre- and post-intervention program.

Based on the successful interventions described in this research it can be concluded that most commonly used ergonomic interventions were primary and secondary, Among them was most often used PEI – physical ergonomic intervention (6 times), then CEI – combined ergonomic interventions have used three times and OEI – organizational ergonomic intervention and finally IEI – individual ergonomic intervention (2 times). Primary physical ergonomic interventions were improvements of working postures or training exercise programs. Primary organizational ergonomic interventions have focused on the problems of organizational level for instance redesigning assembly lines layouts or work environmental interventions. Primary individual ergonomic interventions concentrated on re-design of work place or use of new tools or auxiliaries. Combined interventions use several interventions altogether. Among industrial workers for example there was implemented as individual as far as organizational interventions. In medical field the corrections of working posture, physical and combined ergonomic interventions were used. Among computer workers body posture and workstation corrections were used to decrease risk of MSDs.

In general ergonomic interventions are successful to reduce MSDs at work. Standardized ergonomics methods (RULA, REBA, OWAS, ROSA and OCRA) are most often used interventions. Ergonomic specialists are best suited to develop cost-effective interventions that can be easily implemented. Effective ergonomic interventions used large size of samples, compared the results with the control groups, measured the results in pre- and post-intervention period and these interventions were comparable with other researchers' results. There is no any excuse like illness, money or age not to implement ergonomic interventions.

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