TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 65, Issue Special III, November, 2022

PROPOSAL OF A PREVENTION PROGRAM FOR MITIGATION OF WORK-RELATED MUSCULOSKELETAL DISORDERS

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Abstract: *Work-related musculoskeletal disorders (WMSDs) remain a major concern in the field of ergonomics and occupational health and safety. The reactive approach to ergonomic risks does not provide solutions for prevention of new cases of WMSDs in the workplace. Therefore, the authors consider that creation of a prevention program is a valid solution for elimination of ergonomic risks, as long as prophylaxis initiatives do not negatively interfere with company productivity. The paper is concerned with conception of a prevention program aimed at reducing incidence of WMSDs, starting from the ergonomic risks assessment of a workplace in a waste management company. Additionally, for successful implementation of the prevention program, the authors proposed an informative session to raise awareness of WMSDs and train employees for program implementation.*

Key words: *Work-related musculoskeletal disorders, ergonomic risks, risk assessment, prevention program, awareness.*

1. INTRODUCTION

In the organizational context, the human is part of the work system, being in continuous interaction with the other elements of the system: work environment, tasks and means of production [1]. The worker is the central element of an ergonomic intervention, the main purpose of ergonomics being the adaptation of the work system to individual's particularities.

The work process cannot be accomplished unless all the four elements of the work system are put together. Work environment has a direct impact on worker's health, safety and wellbeing; tasks and means of production have an indirect effect [2].

Inadequate occupational health and safety (OHS) comes with an enormous cost: 4% of global GDP is lost annually through costs incurred with lost working time, interruptions in manufacturing, health costs (treatment of accidents and professional disorders), rehabilitation and compensations [3]. Ergonomic risks have remained a serious concern in the workplace across the globe. In the context of this special attention awarded to OHS in the European Union, the European Agency for Safety and Health at Work (EU-OSHA) has made significant efforts to raise awareness on work-related musculoskeletal disorders (WMSDs) and ergonomic risks through campaigns and dedicated studies. One of these studies, providing relevant data on impact and frequency of WMSDs across companies in the EU is the European Survey of Enterprises on New and Emerging Risks (ESENER). As per the latest edition of ESENER – which awarded special attention to WMSDs – ergonomic risks remain at the top of the workplace risks in European companies: repetitive arm and hand movements, work sitting and manual load handling are in top five workplace risks [4].

In this context, research on ergonomic risks and conception of ergonomic interventions targets at reduction of these risks is mandatory for assurance of OHS and employees' wellbeing. The paper is aimed at conception of a prevention program as part of a wider proposal of ergonomic interventions, starting from the assessment of ergonomic risks in the workplace. The proposed research methodology is validated through an applicative case study for a workplace in a waste management company in Romania.

2. LITERATURE REVIEW

2.1 Prevention programs

A key observation is that WMSDs are generated through inadequate operation of human musculoskeletal system [5]. In the past years, research proved that complex ergonomic interventions that encompass physical exercises, employee trainings, and organizational ergonomic guidelines and best practices are the most successful combination [5,6]. In addition to conception of a prevention program, ergonomists should always consider the importance of trainings and informative sessions organized for all employees targeted by the prevention program. The content of these trainings and sessions should refer to all aspects of the prevention program implementation, in order to ensure correct and successful outcomes. Although in many cases educational programs are treated as separate ergonomic interventions, research indicates that such initiatives are effective as they result in reduction of WMSDs incidence and improvement of overall employees' wellbeing [7]. Raising awareness on WMSDs and ergonomic risks is proven to help employees improve their motor patterns, with positive impact over reports of WMSDs symptoms [7- 9].

Prevention programs focused on including physical exercises gained momentum in the past years. Conception of such programs is complex and requires an interdisciplinary approach, as medical and ergonomics perspective should reunite for the desired outcome.

Another element that should be considered when discussing about WMSDs prevention programs refers to potential barriers that put at risk its success. The major barriers refer insufficient time to switch to the new operating model (that includes ergonomics guidelines and best practices along with the ergonomic intervention), insufficient resources, social, psychological and organizational aspects (such as poor communication, lack of management involvement or resistance to change), insufficient or inaccurate knowledge, and rapidly-changing work environment [10, 11]. While majority of these barriers can be removed through proper trainings and recurrent informative sessions, ergonomic interventions in general should be aligned with organizational goals and strategies. A major concern refers to the economic impact of ergonomic interventions – including prevention programs – [12], as ergonomic interventions represent investments with numerous benefits that cannot be translated into monetary units [13].

Nevertheless, employees' wellbeing should remain a priority within organizations. Consequently, research indicating positive outcomes of prevention programs consisting in a combination of physical exercises, training sessions and ergonomic interventions aimed at workplace optimization are a valid argument for a cost-benefit analysis [13, 14].

Moreover, principles of participatory ergonomics should be followed both during conception of the program and especially during implementation phase [8, 14, 15]. Enhancing organizational communication at all levels, considering employees' perspective in decisional process and creation of interdisciplinary teams are a few of the participatory ergonomics initiatives that can be considered. A study performed by Hess et al. proved that employees who were encouraged to express their concerns and suggestions for workplace safety practices were more engaged in safe behaviors [16]. In the same line, the US National Institute for Occupational Safety and Health initiated a complex program entitled "Total Worker Health", based on participatory ergonomics [17]. The program aims to create workplaces with no hazards and to promote employee wellbeing through specific ergonomic interventions [17].

2.2 Mio-fascial meridian

Actual research, clinical and statistical data in Occupational Medicine show in the last 5-7 years, that WMSDs are constantly among the first five most frequent occupational disorders [18]. Difficulties in pathology assessment are also very well known in common occupational medicine practice. Detection of early signs of WMSDs involve a specific anamnesis and search for clinical findings, followed by assessment of their presence and intensity in correlation with occupational exposures. These aspects involve, in turn, time, experienced occupational health specialist and a very good

professional relationship with those involved in the workplace ergonomic assessments and with doctors specialized in rehabilitation. These principles are also valid in prevention/prophylaxis. Main difficulties in achievement of a proper level of workers monitoring and compliance with ergonomic and medical principles in the workplace are insufficient time dedicated for a proper clinical assessment, the subjectivism in anamnesis of pain related to occupational strains and risks, lack of proper tools for pain assessment, difficulties in quantifying the musculoskeletal over-solicitations in non-occupational exposures of workers [19].

Meanwhile the progresses and research developed in the fields of ergonomics, rehabilitation medicine and occupational medicine allow introduction of new tools which could improve occurrence of WMSDs through measures at primary and secondary levels of prophylaxis.

Our aim is to introduce and present one of these modern concepts: the involvement of myofascial concept as basis for preventing and/or detecting early signs of the degeneration of the musculoskeletal system overstressed in different areas of professional activities. The goal is to develop a series of a prophylactic programs based on this concept.

It is important to mention in the medical understanding the name of musculoskeletal system also includes joints, bursae, all connective tissues organized as tendons and fasciae. Fascia is a ubiquitous anatomical connective tissue of different types, structures, properties that covers in different ways, depths every structure of the body [20]. This is how a structural connection, continuity is created. Fascia has a major contribution to the form, as well as to the function of each tissue and/or organ [21]. Recent research indicate that fascia is also defined as a three-dimensional mechanic and metabolic support [22].

For this paper, myofascial concept will be referred to as one of the most representative parts of the fascia, which creates a warp and weft around and through all the muscles, developing from biomechanical point of view "the meridians" of myofascial [23].

The properties of contraction and stretches characteristic for the muscular tissue define the myofascial as an active fascia. An active tissue has an increased elastic storage capacity. On the contrary, inactive muscular tissue (e.g., lack of exercise, prolonged sitting etc.) induces a multidirectional fiber network and a decreased elastic storage capacity (fibers become stuck together and form tissue adhesions) [22]. So, the myofascial concept has its origin in the movement's diagonals or meridians. These are both anatomical, physiological and biomechanical structures, constantly engaged in a coordinated way to perform the movement [23].

At the same time, the concept of myofascial meridian is directly linked to a holistic way to analyze the movement [24]. This involves a certain sequence, meaning that the order in which each muscle is put into action determines the movement diagonals. The order is also defined by the movement frame, so that each muscle has its well-defined role [25]. Also, it is important to highlight that complex nervous coordination is involved, with essential contribution to the whole mechanism. This way, one complex movement process is executed in two simultaneously and perfectly coordinated sub-processes: posture and equilibrium - right balanced posture (which ensures the support for a precise movement) and the proper movement [25].

Regarding the typical occupational movements, they can be framed and then decomposed according to their own and specific meridian movements [26]. This process requires a detailed and careful observation action at the work place. The purpose is to define which is the most overloaded part of the chain, what is the hierarchy in the occupational solicitations and, based on this, to build an adequate action plan for prevention and/or rehabilitation.

To ensure the efficacy of the prevention program it is necessary to take in consideration the ergonomic risk assessment. It is compulsory to act this way to obtain a customized prevention program with real chances of success.

Combining and interpreting all the information serves to achievement of a specific goal: to identify the importance of the muscles

in the motion and to assess the risk of overuse. Therefore, conception of a prevention program incorporates all these data and should be customized for each workplace or type of activity, aiming to reduce incidence of WMSDs and to enhance workplace wellbeing [27].

Next step is to identify the type of movements which can, by exercising, prevent the overload.

There are 12 specific myofascial meridians throughout the body [24], presented in Table 1.

Table 1

Myofascial meridians.

Myofascial meridian	Abbreviation
Superficial Back Line	SBL
Superficial Front Line	SFL
Lateral Line	LL
Spiral Line	SL
Superficial Front Arm Line	SFAL
Deep Back Arm Line	DBAL
Deep Front Arm Line	DFAL
Superficial Back Arm Line	SBAL
Back Functional Line	BFL
Front Functional Line	FFL
Ipsilateral Functional Line	IFL
Deep Front Line	DFL

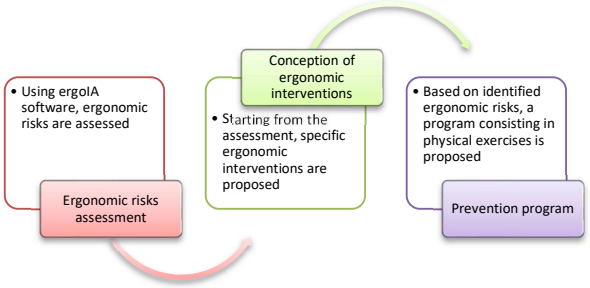

Fig. 1. Research methodology.

3. RESEARCH METODOLOGY

To correctly conceive a prevention program, it should be customized for a specific workplace. Therefore, the research methodology consists in a general framework applicable in various organizations.

As per Figure 1, the methodology consists in three main stages: assessment of ergonomic risks, conception of ergonomic interventions and conception of the prevention program.

Assessment of ergonomic risks can be performed using a variety of methods, depending on researcher's knowledge and experience. However, software tools come as a support for ergonomists, enhancing and simplifying the process. One of these tools is ergoIA, a software launched in 2021, which uses artificial intelligence to perform ergonomic risk assessments based on REBA and OWAS methods [28] (and also similar studies of musculoskeletal strengths and occupational safety depicted in [29-31]).

The second stage consists in conception of ergonomic interventions starting from the ergonomic risk assessment performed in the previous stage. Combined with direct observations, the ergonomic interventions include measures of risk reduction through technical and organizational measures, risk reduction at sources and at worker's level.

In addition to the ergonomic interventions, the interdisciplinary approach suggested in chapter 2 is obtained by conception of a prevention program by medical specialists. The prevention program consists of a series of physical exercises to reduce muscle strain and improve overall wellbeing.

The program aims to reduce impact of ergonomic risks and to avoid incidence of WMSDs. Chapters 4 and 5 describe how the research methodology was applied in the case of operators of a PET recipients press in a waste management company in Romania.

4. THE CASE OF ERGONOMIC RISKS ASSESSMENT

4.1 Ergonomic risks assessment

As presented in Figure 1, a prevention program should be conceived starting from the assessment of ergonomic risks for a specific workplace. Therefore, ergonomic risks were evaluated at a waste management company, particularly for operating a PET press in the recyclable waste section. The PET press is operated by two employees who perform the following tasks:

- Moving in the operation area metal containers filled with sorted PET recipients (through pushing and dragging movements);

- Placement of each container in the elevator;
- Control panel operation to execute evacuation of PET recipients in the press, followed by automatized pressing of the recipients and their evacuation in the form of compressed bales;
- Removing the empty container from the operation area.

The above tasks are re-iterated for each container for the whole duration of the work shift. The containers are made of steel and weight ~130 kg when they are empty.

Table 2

Main postural strains identified at analyzed workplace.

Postural strain	Observations
Work standing	No possibility to rest or alternate with other postures (e.g., sitting), except for a single 30-minutes break
Uncomfortable / awkward postures	Maintain an arm above the shoulder during operation of press control panel
Manual load handling (pushing, dragging)	Load manipulation involves dragging and pushing containers for a distance of several meters on a route with obstacles (large cracks in the floor) exposing the operators to risk of stumbling and creating shocks in the musculoskeletal system; manipulated load weights between 130 kg (empty container) and 180 kg (filled container)

Fig. 2. The main postures adopted by operators of the PET press.

Work regime consists of two shifts with an 8-hours duration; employees have a 30-minute lunch break (not included in the 8-hour shift duration) in a cafeteria, which serves as resting area, too. Employees work solely in standing position, without possibility of alternating with other postures (except for the lunch break). The main postural strains identified are described in Table 2.

As described in previous chapter, the assessment of ergonomic risks was performed using ergoIA software. Figure 2 presents main postures adopted by the operators. The video recording was split in 30 frames to obtain the desired level of detail for the assessment based on REBA method.

In the case of PET press operators, the general REBA score indicates medium risk level, supported by the fact that although 60% of the frames had a score of 1, a significant share of frames had a score of 3, 4 or 5 (indicating medium risk). Therefore, the existence of postures with scores of 4 and 5 involves requirement of immediate action to reduce ergonomic risks. Figure 3 presents distribution of REBA scores for the analyzed tasks.

Particularities of REBA method did not enable a thorough analysis of the ergonomic risks and, as consequence, authors also performed ergonomic risks assessment using OWAS method (via ergoIA software). Fig. 4 presents frequency of identified postures based on OWAS assessment. The dominant postures are twisted back (80%), one arm above shoulder (78%, posture maintained during control panel operation), and standing (60%). Other postures with relevant frequency are walking (22%), standing on one foot (18%), straight back (18%) and both arms above shoulders (12%).

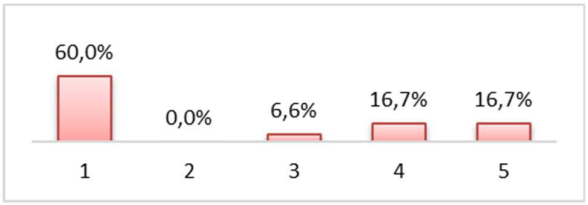

Fig. 3. Distribution of general scores, REBA method.

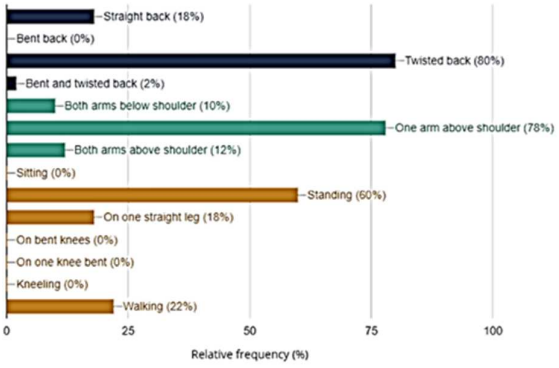

Fig. 4. Frequency of identified postures, OWAS method.

Despite the generally high reliability of assessments performed with REBA and OWAS methods, in the case of the studied workplace there were a few risks not accurately assessed through this approach. Therefore, based on authors' experience and observations, these risks were further studied to reflect the real implications.

One mention that should be made here is that none of the two assessments reflected a significant ergonomic risk: on the route for transport of containers (forth and back to the PET press) the pavement had several deep cracks that increase manipulation effort, create shocks for musculoskeletal system and pose additional risk in terms of workplace accidents during execution of the task – risk of tripping.

Table 3

Proposed ergonomic interventions for optimization of the analyzed workplace.

Identified risk/problem	**Proposed solution**
Technical and organizational interventions	
Operators perform repairs by entering the baling area inside the press (where PET recipients are baled)	Occupational health and safety training for employees to reduce improper operation of the machine
Control panel is positioned at a high level, causing operators' uncomfortable postures	Using a one-step ladder to eliminate necessity of adopting the uncomfortable postures during control panel operation
Metal containers may have deformations that generate risk of containers falling from the automated elevator that lifts and empties the content in the press	Recurrent verification and replacement of deformed containers
High number of movements and steps made to bring and remove the containers in the press area	Projection of a system for optimization of this operation
Work standing without possibility of alternation with other postures	Change of work shift organization by introduction of short breaks (5-10 minutes) for rest by placing chairs for employees to sit down at the workplace
Work in uncomfortable postures, work standing	Allowing and encouraging micro-breaks for muscle relaxation; encouraging employees to perform short series of exercises to relax muscle groups overstressed during work
Work in uncomfortable postures, work standing	Job rotation after a set period of time
Risk reduction at source	
Cracks in the concrete floor on the route of containers transport, with increased risk of accidents and higher manipulation effort	Clogging the floor cracks and leveling the entire hall flooring (with self-leveling screed casting)
High load handling	Installation of a tipping container to enable automated spill of PET recipients in the press, thus eliminating necessity of manipulating containers
Risk reduction at operator's level	
Operators' unsafe practices such as entering inside the balling area of the press or improper container manipulation	Organizing recuring training sessions additional to legally compulsory trainings in the fields of occupational health and safety on the following themes: 1. Postural strains and means to correct posture during work; 2. Importance of using protective personal equipment (PPE) with no exceptions to limit negative impact of risks generating accidents during machine operation

Another factor to be considered is that high load handled by PET press operators through actions of pushing and dragging: the nominal weight of a metal container is 130 kg, while a full container weights up to 180 kg. These operators do not have any mean of automation for transport of containers, immediate action being required for reduction of ergonomic risks.

All the postures described have short duration, but a high frequency. The identified ergonomic risks add to the main postural stress represented by work standing and act as aggravating factor. The effects of the postural stress translate into muscular fatigue, high risk of errors during task execution, occurrence of discomfort and even pain in certain body regions; in cases where exposure is repetitive for

a long period of time, acute and chronic symptoms of WMSDs may occur.

4.2 Proposed ergonomic interventions

Starting from the assessments presented in previous subchapter, the authors conceived ergonomic interventions aimed at reduction (or elimination, where possible) of identified ergonomic risks. Table 3 presents ergonomic interventions organized by type of intervention (technical and organizational, risk reduction at source, risk reduction at operator level).

The ergonomic interventions proposed in Table 3 can be implemented during various time spans, as some of them are oriented towards immediate correction/elimination of severe workplace risks, while other interventions aim to optimize the workplace.

5. PREVENTION PROGRAM - DESCRIPTION AND IMPLEMENTATION

The ergonomic interventions proposed in chapter 4 target correction (optimization) of the current status quo. However, harm has been done in terms of employees' wellbeing, as exposure over the long term negatively impacted employees' health. In order to prevent this, a prevention program should be implemented at the same time with the other ergonomic interventions. This chapter is dedicated to conception and proposed implementation methodology for a prevention program aimed at reduction of WMSDs incidence in the analyzed workplace and to help maintain a good work capacity.

The ergonomic risk assessments revealed is that there are some uncomfortable movements and postures that cannot be avoided. According to the myo-fascial meridian theory each and every occupational movement has a pattern involving a precise sequence of muscles [24]. The occupational medicine specialist will identify the most vulnerable area in the scheme of movement, followed by reporting it to the corresponding myofascial meridian (the meridian involved in that type of movement).

The vulnerable area is predisposed to muscle contractures, which can be prevented with stretching movements.

The most appropriate prevention program consists of exercises which combine targeted stretching movements on the identified vulnerable muscular groups with whole body vibration movements. Stretching movements are essential in activating the muscle fascia, preventing this way the adhesions which impair the correct and efficient movement [29].

Another very efficient and easy exercise to prevent the overload and the over-use risk is the whole-body vibration [30]. This is a simple, proximo-distal repetitive shaking movements technique, with a duration of 1 minute – 1.5 minutes. It consists in: head and neck bending, shoulders and whole arms shaking, trunk bending, pelvic rotation, finishing with leg shaking and whole body shaking in standing position.

The expected effects of the prevention program are: muscle relaxation, an improvement of local superficial and deep blood circulation, lymph drain effect and very important - prevention of muscle contractions mostly in the vulnerable areas [31]. This way, also the muscle fatigue is prevented due to a better tissue oxygenation.

These exercises prevent the formation of the adhesions in the muscle fascia, respectively, they prevent adhesions which – once formed – would impair the correct movement, leading to development of acute and chronic manifestations of WMSDs. Additionally, the proposed prevention program is expected to also lead to benefits such as stress relief.

Nonetheless, successful implementation of the program is highly dependent on knowledge sharing and conception of procedures and best practices.

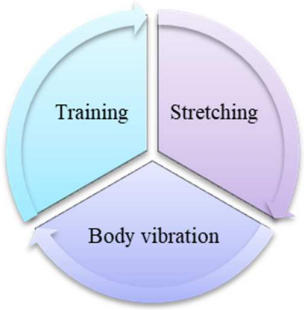

Fig. 5. Methodological framework for WMSDs prevention program.

In this context, the authors underline the necessity of organizing dedicated training sessions with both managers and employees to ensure correct execution of the exercises and importance of respecting doctors' instructions in this respect. Raising awareness on WMSDs and their negative impact on productivity and employee wellbeing should also be part of the proposed training session. The efficiency of such a customized prevention program depends on motivation and information of employees. Figure 5 presents the proposed framework for prevention program implementation as described in this chapter. The challenge is to find a common denominator among the employer and the employees in understanding and application of the preventive methods, focusing on the goal of both health and productivity maintenance.

A potential limitation of the proposed framework si the requirement to adapt the prevention program to specific risks and particularities of various workplaces. However, the proposed methodological framework has a general character, meaning that it is easily adaptable to a wide variety of work instances. Therefore, the authors opinion that this methodological framework can be used for prevention of WMSDs across industries.

6. CONCLUSIONS

WMSDs remain a significant concern across industries, as many employees across the world still confront themselves with symptoms such as pain, temporary impairment or decline in quality of life. A disturbing aspect is that in many cases these disorders remain undiagnosed until occurrence of chronic manifestations of WMSDs. In this context, the paper provides a methodological framework that is easy to use in any company and increases chances of correct and rapid identification of ergonomic risks. Further, the framework is applied in the case of a workplace – PET press machine operating in a waste management company.

Ergonomic risks identified revealed the main postural strains to which employees were exposed during execution of tasks. This was the baseline for conception of ergonomic interventions aimed at reduction of the risks and optimization of the workplace (like [30-35]). Interest was granted to conception of a prevention program consisting of physical exercises that should be executed during the work shift for muscle relaxation and reduction of strains. These exercises consist in short series of stretching and body vibration, with additional benefits such as stress relief.

A key takeaway is that the training preceding implementation of the prevention program should offer easily understandable explanations of the prevention program and its beneficial effects.

Other aspect that might impact success of the program are workers correctly performing their tasks, employers who ensure high compliance with ergonomic principles, continuous and thorough workplace risk assessments and corresponding risk reduction actions, workplace trainings about the ergonomic risks and the benefits of the prevention program, 100% participation of the employees to the prevention program. As a conclusion, the whole approach is an example of how ergonomic assessments can be tackled. At the same time, this approach is easily transferrable for any workplace, irrespective of country or industry, demonstrating the scientific value of this research.

7. REFERENCES

[1] Irimie, S., *Ergonomie Industrială*, Editura AGIR, ISBN 978-973-720-196-6, București, 2008.

[2] Darabont, D., *Managementul securității și sănătății în muncă. Ghid de evaluare a conformării cu cerințele legale*, Editura AGIR, ISBN 978-973-720-329-8, București, 2010.

[3] International Labor Organization, *Working Together to Promote a Safe and Healthy Working Environment*, International Labour Conference 106th session 2017, http://www.ilo.org/wcmsp5/groups/public/---ed_norm/---relconf/documents/meetingdocument/wcms_543647.pdf.

[4] European Agency for Safety and Health at Work, *Third European Survey for Enterprises on New and Emerging Risks (ESENER 3),* https://osha.europa.eu/ro/publications/third-european-survey-enterprises-new-and-emerging-risks-esener-3/view.

[5] da Silva, N. C., Ricci, F. P. F. M., de Castro, V. R., de Lima, A. C. R., do Carmo Lopes, E. R., de Salvo Mauad, L. D., ... & de Cássia Registro Fonseca, M., *Effects of workplace upper extremity resistance exercises on function and symptoms of workers at a tertiary hospital: a randomized controlled trial protocol*, BMC musculoskeletal disorders, 23(1), pp. 1-8, 2022.

[6] Chim, J. M., Chen, T., *Implementation of an Office Ergonomics Program to Promote Musculoskeletal Health: A Case Study in Hong Kong*, IISE Transactions on Occupational Ergonomics and Human Factors, 9(2), pp. 96-105, 2021.

[7] Denadai, M. S., Alouche, S. R., Valentim, D. P., Padula, R. S., *An ergonomics educational training program to prevent work-related musculoskeletal disorders to novice and experienced workers in the poultry processing industry: a quasi-experimental study*. Applied Ergonomics, 90, p. 103234, 2021.

[8] Bahrami-Ahmadi, A., Hoseini, H. R., Kabir-Mokamelkhah, E., Dehghan, N., & Aghilinejad, M., *Impact of two ergonomics training on prevalence of upper and lower extremity complaints among nurses*, Journal of Education and Health Promotion, 10, 2021.

[9] Sholihah, Q., Hanafi, A. S., Bachri, A. A., Fauzia, R., *Ergonomics awareness as efforts to increase knowledge and prevention of musculoskeletal disorders on fishermen*, Aquatic Procedia, 7, pp. 187-194, 2016.

[10] Virmani, N., Salve, U. R., *Assessment of key barriers for incorporating ergonomics inventions and suppress work-related musculoskeletal disorders,* Materials Today: Proceedings, 38, pp. 2601-2606, 2021.

[11] Koma, B. S., Bergh, A. M., Costa-Black, K. M. *Barriers to and facilitators for implementing an office ergonomics programme in a South African research organisation*, Applied Ergonomics, 75, pp. 83-90, 2019.

[12] Weckenborg, C., Thies, C., Spengler, T. S., *Harmonizing ergonomics and economics of assembly lines using collaborative robots and exoskeletons*. Journal of Manufacturing Systems, 62, pp. 681-702, 2022.

[13] Dăscălescu, A., *Modele de calcul al costului accidentelor de muncă și bolilor profesionale*. Editura OEDI-INCDPM, ISBN 978-606-92116-5-6, București, 2010.

[14] Allespach, H., Sussman, M., Bolanos, J., Atri, E., & Schulman, C. I., *Practice longer and stronger: maximizing the physical well-being of surgical residents with targeted ergonomics training*, Journal of surgical education, 77(5), pp. 1024-1027, 2020.

[15] Rasmussen, C. D. N., Lindberg, N. K., Ravn, M. H., Jørgensen, M. B., Søgaard, K., Holtermann, A., *Processes, barriers and facilitators to implementation of a participatory ergonomics program among eldercare workers*, Applied ergonomics, 58, pp. 491-499, 2017.

[16] Hess, J. A., Kincl, L., Weeks, D. L., Vaughan, A., Anton, D., *Safety voice for ergonomics (SAVE): evaluation of a masonry apprenticeship training program*, Applied ergonomics, 86, p. 103083, 2020.

[17] National Institute for Occupational Safety and Health, *Fundamentals of Total Worker Health Approaches*, https://www.cdc.gov/niosh/docs/2017-112/pdfs/2017_112.pdf.

[18] National Institute for Occupational Safety and Health, Fundamentals of Total Worker Health Approaches, https://www.cdc.gov/niosh/docs/2017-112/pdfs/2017_112.pdf.

[19] World Health Organization, Musculoskeletal conditions, https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions

[20] Avison, J., *Yoga, fascia, anatomy and movement*, Handspring Publishing Limited, 2021.

[21] Trimbitas, C. L., *Corelații anatomo-funcționale și terapeutice ale structurilor coloanei vertebrale și membrelor superioare cu suprasolicitările profesionale*, PhD thesis, Universitatea Oradea, Oradea, 2014.

[22] Gatt, A., Agarwal, S., Zito, P. M., *Anatomy, Fascia Layers,* https://pubmed.ncbi.nlm.nih.gov/30252294/

[23] Dischiavi, S. L., Wright, A. A., Hegedus, E. J., Bleakley, C. M., *Biotensegrity and myofascial chains: a global approach to an integrated kinetic chain*, Med. Hypotheses, 110, 2018.

[24] Myers, T. W., *Anatomy trains e-book: Myofascial meridians for manual therapists and movement professionals*, Elsevier Health Sciences, 2020.

[25] Lavelle, E. D., Lavelle, W., Smith, H. S., *Myofascial trigger points*, Anesthesiology clinics, 25(4), 2007.

[26] Bogdan, R., Bucur, A., Chiriac, M., Ciobanu, D., Cristea, D., Dan, M., ..., Tarcău, E., *Kinetoterapie/Physiotherapy*, Editura Universităţii din Oradea, Oradea, 2006.

[27] Boatca, M. E., Draghici, A., Carutasu, N., *A knowledge management approach for ergonomics implementation within organizations*,

Procedia-Social and Behavioral Sciences, 238, 2018.
[28] Gajšek, B., Draghici, A., Boatca, M. E., Gaureanu, A., Robescu, D., *Linking the Use of Ergonomics Methods to Workplace Social Sustainability: The Ovako Working Posture Assessment System and Rapid Entire Body Assessment Method*, Sustainability, 14(7), p. 4301, 2022.
[29] Draghici, A., Vaduva, R., Capotescu, S., Banaduc, G., Robescu, D., *Innovations for Tackling Post-Pandemic Related Challenges-A Collaborative Research to Discover New Solutions for Hybrid Work in The Context Of 15-Minute Cities*, Acta Technica Napocensis-Series: Applied Mathematics, Mechanics, and Engineering, 65(1S). 2022.
[30] Choong, S. W. J., Ng, P. K., Yeo, B. C., Draghici, A., Gaureanu, A., Ng, Y. J., ..., Selvan, H. K. T., A *Preliminary Study on Ergonomic Contribution to the Engineering Design Approach of a Wheel Loader Control Lever System*, Sustainability, 14(1), 122, 2021.
[31] Dufour, C., Draghci, A., Ivascu, L., Sarfraz, M., *Occupational health and safety division of responsibility: A conceptual model for the implementation of the OHSAS 18001: 2007 standard*, Human Systems Management, 39(4), 549-563, 2020.
[32] Van Eerd D., Munhall C., Irvin E., et al., *Effectiveness of workplace interventions in the prevention of upper extremity musculoskeletal disorders and symptoms: an update of the evidence,* Occupational and Environmental Medicine, 73, 2016.
[33] Wu, W. T., Hong, C. Z., Chou, L. W., *The kinesio taping method for myofascial pain control*, Evidence-Based complementary and alternative medicine, 2015.
[34] Szabó, G., Balogh, Z., Dovramadjiev, T., ..., Zunjic, A., *Introducing the ergonomics and human factors regional educational CEEPUS Network*, Acta Technica Napocensis-Series: Applied Mathematics, Mechanics, and Engineering, 64(1-S1), 2021.
[35] Baesu, V., Albulescu, C.T., Farkas, Z.B., Draghici, A., *Determinants of the high-tech sector innovation performance in the European Union: a review*. Procedia Technology, 19, 371-378, 2015.

Propunerea unui program de intervenție pentru reducerea afecțiunilor musculoscheletale generate de viața profesională

Rezumat: Afecțiunile musculoscheletice (AMS) ce își au originea în activitatea profesională (AMS) rămân o problemă majoră în domeniul ergonomiei și al securității și sănătății în muncă. Abordarea reactivă a riscurilor ergonomice nu oferă soluții pentru profilaxia noilor cazuri de AMS la locul de muncă. Astfel, concepția unui program de prevenție poate fi o soluție viabilă pentru eliminarea riscurilor ergonomice, atât timp cât inițiativele de prevenție nu interferează negativ cu productivitatea firmei. Lucrarea tratează concepția unui program de prevenție orientat înspre reducerea incidenței AMS, pornind de la evaluarea riscurilor ergonomice la un loc de muncă dintr-o firmă prestatoare de servicii de salubrizare. De asemenea, pentru implementarea cu succes a programului de prevenție, autorii propun o sesiune de informare pentru creșterea gradului de conștientizare privind AMS și pentru instruirea angajaților pentru implementarea programului.

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