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# Impact of Psychological Stress on the Development of Musculoskeletal Diseases

**Denisa Porubčanová [1,*], Michaela Balážiková [1], Peter Darvaši [1], Lukáš Ďuriš [1], Ivan Habala [1], Hana Pačaiová [1]**

[1] Technical University of Košice, Faculty of Mechanical Engineering, Department of Safety and Quality, Letná 1/9, 042 00 Košice-Sever

**Abstract:** This article deals with the issue of the incidence of musculoskeletal diseases in Slovakia in the long term and the possible relationship between their occurrence and the presence of psychological stress. According to statistics, these diseases are a long-term problem plaguing employees in various work sectors and age groups. Their occurrence contributes to the long-term incapacity for work of employees or to their work restrictions, which often require the reassignment of the affected employee to another job or even his or her complete exclusion from employment. This has a negative impact not only on the health of the employee, but also on the operation of the company and its economy, so it is necessary to introduce appropriate preventive measures. Although much attention is focused on the physical aspect, many studies have shown a link between psychological stress and the development of musculoskeletal diseases. It is therefore necessary to address this factor and to incorporate appropriate methods for assessing psychological stress in the workplace and subsequent adequate measures. This paper deals with the design of a matrix for the assessment of psychological stress at work, which is easily applicable in practice.

**Keywords:** occupational diseases, musculoskeletal diseases, physical workload, psychological stress

## 1. Introduction

Occupational diseases are a long-standing problem that afflicts people all over the world, regardless of their specific occupation, gender, or age group. Statistics and research show that in addition to diseases caused by vibration exposure, hearing impairment, respiratory diseases, or diseases due to exposure to hazardous substances, musculoskeletal disorders, often attributed to excessive workload, unilateral loading or monotonous work with incorrect postures, i.e. musculoskeletal disorders (MSDs), are at the top of the list. [1] These diseases affect the human musculoskeletal system, thus affect bones, muscles, joints, tendons, and other connective tissues. Musculoskeletal disorders are characterized by soreness of the affected area, which severely restricts a person's mobility and performance, which will also affect the efficiency and quality of their work [2]. MSDs occur in different forms and affect different areas of the body. From a temporal point of view, they can be acute conditions, long-term conditions, but also conditions transitioning into a chronic form, often requiring resting and thus leading to incapacity of the employee, which is a problem especially in the case of long-term illness, or its chronic form. Frequent and prolonged absences due to sick leave not only have a negative impact on the organization and operation of the enterprise, but also affect its economy. They also have an adverse effect on a person's overall health, which is impaired by the presence of the disease and limits them in both their working and everyday life. The disproportionate burden can lead to disability and the complete

*** Corresponding author:** Denisa Porubčanová, ***E-mail address:*** *denisa.porubcanova@tuke.sk*

exclusion of the affected employee from working life. Their psyche is also affected, as the presence of pain brings with it a sense of discomfort and restriction. These are the reasons why corporate safety should be concerned with workplace ergonomics, working conditions and the implementation of preventive safety measures [2, 3].

## 2. Experimental Materials and Methods

### 2.1 MSD prevalence statistics

The 2019 Global Burden of Disease statistics [4] show that musculoskeletal diseases are a global problem. In that year, 1.71 billion people worldwide were identified as suffering from MSDs, with the most common problem being spinal pain, specifically in the sacral area, reported by up to 570 million people. Furthermore, fractures, osteoarthritis, neck pain and many others were also frequently reported within MSDs. Although these diseases are reported in different age groups, research and statistics show that the incidence of MSDs increases proportionally with age, but with the passage of time, an increase in MSD cases is observed in younger people [2].

Similarly, Slovak statistics show that MSDs are a long-term problem that has persisted for more than twenty years. Published NCZI statistics [1] show that in the period from 2002 to 2022, MSDs ranked high in the rankings of recognised occupational diseases. It is thus an obvious problem that requires attention and calls for the implementation of appropriate preventive and safety measures in workplaces, not only to support businesses but especially to protect the health of employees [1, 5].

A fluctuating trend in the incidence of occupational diseases can be observed in the aforementioned time period 2002-2022 [Figure 1]. Although there was a decrease in cases between 2011-2020, the number of cases increased again significantly between 2021 and 2022. Although it should be noted that the increased number of cases was also contributed to by the occurrence of the COVID-19 pandemic, these figures should nevertheless not be considered irrelevant, as the incidence rates of MSDs and other occupational diseases also remain high. The latest statistics for 2022 show that the total number of recognised occupational diseases is 525, of which up to 164 cases were MSDs, placing them second on the list of occupational diseases for 2022. Infectious diseases were the more numerous group, with 252 cases being recognised. Additionally, in terms of age groups, employees aged 55-59 years were the most affected group and the most affected occupational sector was health and social care [1].

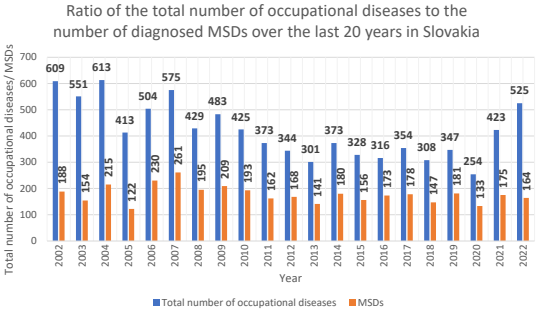


Figure 1: Ratio of the total number of occupational diseases to the number of detected MSDs over the last 20 years in Slovakia [1].

From Figure 1, it is evident that the number of recognized MSDs caused by work has long been well above the threshold of 100 cases per year. The highest number of cases of MSDs in the last 20 years was recorded in 2007, when the number rose to 261 out of a total of 575 detected cases, which accounted for 45.4%. However, the proportion of recognized MSDs out of the total number of recognized occupational diseases has not fallen below 43% from 2006 until 2021, suggesting that MSDs are indeed a demonstrable problem. Although in 2022 the proportion of MSDs has fallen to 31.27% of the total number of recognized cases, it should be emphasized that a large proportion of the recorded cases for this year were infectious diseases [1].

### 2.2 Factors influencing the onset and development of MSDs

During a lifetime, person is exposed to many factors that affect the organism to varying degrees, which can have both positive and negative effects and can cause damage and disease. Likewise, the factors involved may also contribute to the development of MSDs. In the assessment of physical stress, which is the main trigger for the development of MSDs, the following parameters are mainly assessed:

- *Anthropometric data, gender.*
- *Body posture, working postures.*
- *Weight of load/force used to move it.*
- *Frequency of work.*
- *Time interval - duration of work.*
- *Movements performed.*

– *Work pace/speed of work.*
– *Rest, relaxation, recovery.*
– *Subjective perception, worker's feelings.*
– *Other parameters [5].*

When assessing the workload, environmental factors arising from the work environment are also considered, as well as psychosocial factors. Negative factors often include job dissatisfaction, lack of social support, disagreements within the work team, disproportionately low pay, high work demands, ambiguous work organization and many other factors that affect the psychological and physical aspects of the body, influence its function and can be triggers for illness. Undoubtedly, the overall physical condition of the employee and genetic predispositions, which also influence the susceptibility to the development of diseases, is also a significant factor in the occurrence and development of MSDs [5, 6].

Literature [7] reports that over the past 20 years, several studies have supported a complex and multifactorial etiology of work-related MSDs. The risk factors operating in the workplace can be divided into 3 categories:

*1. Physical and biomechanical hazards related to physical activities or the ergonomic nature of the workplace (e.g. incorrect work postures, poor posture, excessive loads, etc.).*

*2. Psychosocial risks (e.g. workplace relations, high work demands, poor financial remuneration, etc.).*

*3. Individual risks (e.g. age, gender, genetic predispositions, etc.) [7].*

Research [8, 9] also points to a correlation between the development of MSDs and sleep disturbances, which can develop because of physical and psychological stress. Sleep is an irreplaceable physiological mechanism for the human organism, which serves to regenerate and replenish energy. Therefore, disruption of its regularity, quality and cycle has a negative impact on overall health, causing a decrease in energy, increased sensitivity to pain and other stimuli, a decrease in performance and a decrease in motivation. Sleep disturbances, due to the body's lack of recovery, cause neuromuscular fatigue, a decrease in the rate of muscle contraction and the extent of muscle relaxation, thus contributing to an increased risk of developing MSDs [8, 9].

**2.3 The impact of psychological stress on the onset and development of MSDs**

Although the link between the presence of psychological stress and the development of MSDs has been demonstrated by several studies, the exact mechanism of the interaction between these two factors has not yet been accurately determined. Several theoretical models have been published [5, 7, 10, 11, 12, 13], but research in this regard is inconsistent. There may be several reasons for the differences, among them inconsistent definition and measurement of psychosocial aspects of work, making it difficult to assess the relative influence of stressors on the development of MSDs. The way in which the scope of the issue is perceived is also problematic, as research focuses selectively on the relationship between psychological stress and MSDs, which is inappropriate due to the complexity of the human psyche and the influence of many environmental factors, as it is not possible to specify exactly which stressor has an impact on the development of MSDs. It is necessary to look at this issue in a comprehensive way and to consider all the factors at work [5].

The exact mechanism of action of psychological stress on the development of MSDs is probably equally complex, as many studies and publications [10-13] demonstrate their interconnectedness, but they disagree in describing the specific mechanism by which psychological stress acts on the musculoskeletal system and causes its damage and disease. Research supports the hypothesis of synergistic effects between psychosocial factors and biomechanical factors that influence MSDs [7].

In their research, Eatough and colleagues [5] discuss that research on psychological stress was already conducted by scientists at the end of the last century, and the so-called transactional approach of the influence of the psyche on the organism was described. The essence of the described transactional approach is that the work environment and the stressors associated with it, induce stress reactions in a person, which in turn influence the attitudes and behaviors of workers. With prolonged exposure, there is an internal tension involved in increasing the risk of developing MSDs [5].

Another model of the interrelationship between psychological stress and MSDs, the so-called Sauter and Swanson model, was built on the principle of this transactional approach. The model works with the theory of the physiological effects of experiencing psychological strain, and in addition to the transactional approach, its theory is extended

to consider the reverse effect and thus the negative impact of the presence of MSDs on the psyche. It suggests that it is the presence of MSDs, manifested by pain and restriction of mobility of the affected body segment, that negatively affects the psyche and contributes significantly to an increase in mental occupational stress [5].

The collective of authors, Afsharian et al. [7], highlights the many proven effects of physical influences on the development of MSDs, such as lifting heavy loads, inappropriate and repetitive movements and postures at work, exposure to vibration, and sedentary occupation. At the same time, however, they point to the influence of psychological stress on the physical side of the body. They state that psychological stress triggers physical reactions and biochemical processes in the body that increase muscle tone, which, with prolonged exposure, puts a strain on the musculoskeletal system. There is also a reduction in blood flow to the extremities and impaired tissue regeneration capacity. Permanent activation of low-threshold motor units is induced due to psychological stress factors, causing increased tissue vulnerability [7]. Research conducted in 2022 by Tang et al. on a sample of nurses confirms that lack of support from the team and supervisors was involved in increasing the risk quotient for the development of MSDs in the neck, shoulder, and back, as were factors related to inappropriately demanding work pace and demands but does not further elucidate the principle of action [10].

Another model, from 2014 [11], attributes the onset of MSDs to the direct action of stress on the muscle fiber. Continuous protein exchange, which ensures the functional integrity and quality of skeletal muscle, is regulated by hormones. Anabolic hormones, such as growth hormone or testosterone, increase protein synthesis and decrease protein breakdown. Stress hormones, on the other hand, have a negative effect on protein levels, causing their catabolism, thus reducing muscle strength. The action of stress hormones also causes oxidative damage to skeletal muscle and impairs its quality and function. The presence of acute daily stress induces atrophic gene expression and loss of muscle mass. It is this weakening of muscle fiber that is a promoting factor for the development of MSDs [11].

It is this theory of muscle fibers damage that Gallagher and Barbe follow in their publication [12]. The authors discuss that the development of MSDs is not only related to biochemical cascades and their effects on muscle fibers but is also promoted by the inhibition of regeneration and the ability to heal. Psychological stressors interfere with the body's neuroendocrine and immune responses, which disrupts the very process of tissue healing. Consequently, there may be reduced fatigue activity of musculoskeletal tissues and increased vulnerability of the injured tissue, due to accumulating damage because of the prolonged healing process. Tissue studies suggest that the reduced kinetics of the healing process when subjected to mechanical loading, can significantly reduce the fatigue life of tissues, which can lead to tissue damage and subsequent MSDs [12].

Bongers et al. also discuss that the link between the presence of psychological stress and the occurrence of MSDs is evident and proven, although it is not yet clear exactly how it works. However, in addition to the factors already mentioned, personality traits and lifestyle may also enter into this cycle, which largely influence the organism and its ability to cope with stress and also its capacity for recovery [13].

## 3. Proposal for the assessment of psychosocial risks at work

The legislative framework for the assessment of psychological and physical burden in the Slovak Republic is given by Decree of the Ministry of Health of the Slovak Republic No. 542/2007 Coll. on details of health protection against physical load at work, mental occupational stress and sensory burden at work provides requirements for the place of work in relation to limiting increased physical load at work, total physical and local muscular load, working positions and measures to prevent excessive physical load. The procedure for assessing psychological workload, the criteria for increased work-related stress and the measures to eliminate or reduce to the lowest possible and achievable level increased mental occupational stress are described in Sections 5 to 7 of this Decree [14].

In the following part, the proposed methodology for assessing psychosocial risks using the risk matrix is described, identifying areas of stress, the so-called stressors, and their consequences, which are evaluated in two impacts: impact on safety (human error/injury); impact to health (impact also on MSDs).

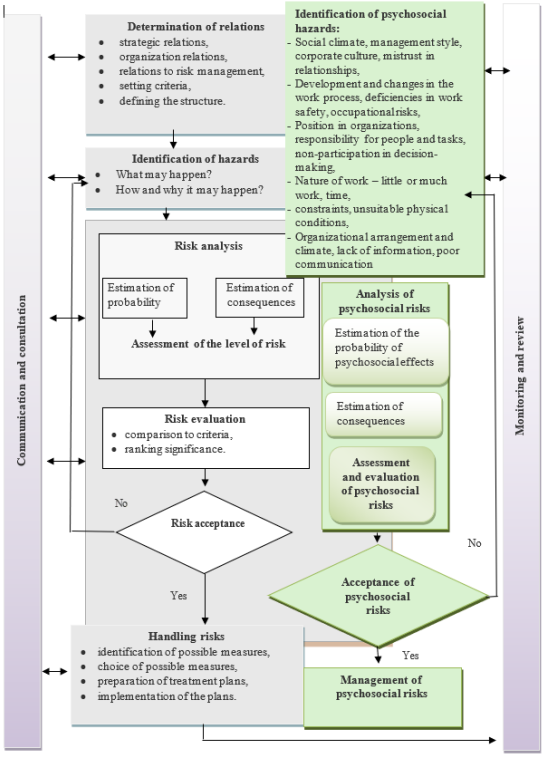


Figure 2: Proposed algorithm for psychosocial risk assessment.

Psychosocial risks in the workplace can be assessed according to the following seven steps:

*1. Preparation - data collection in the form of questionnaires and measurements.*

*2. Identification of stressors, their sources and intensity of their occurrence.*

*3. Estimation of risk according to the intensity of stressors (estimation of the probability and severity of health consequences of stressors, error rate and estimation of the magnitude of risk).*

*4. Proposal of measures to eliminate or reduce the effects of risk stressors at work, considering their severity, documenting the risk assessment.*

*5. Implementation of the proposed measures.*

*6. Repeating the psychosocial risk assessment.*

*7. Evaluation.*

Figure 2 shows the procedure for assessing psychosocial risks causing stress to employees at work.

Once the sources and potential occurrence of stressors (called Stress Hazards) have been identified, the risk is estimated by determining the risk parameters for each individual hazard. The risk is derived by combining the parameters of severity of damage to life and health, probability of occurrence of an adverse event (Table 1).

Psychological stress can arise for various reasons, including the work factors listed in Table 1. These include, for example, insufficient qualifications for work, excessive work pace or excessive workload, long or inflexible working

Table 1: Basic characteristics of sources of stress hazard and their effects on humans.

| *Sources of stress hazards* | *Intensity of exposure to stress* | | *Manifestation of stress exposure* | *Health consequences* |
|---|---|---|---|---|
| Circumstances arising from the performance of work | Short-term, only for certain irregular activities | | Increase in blood pressure.<br>Depressed mood<br>Excessive drinking of alcohol.<br>Irritability<br>Chest pain, and the like. | Chronic diseases, e.g. of the heart<br>Mental illness<br>Disability<br>Death |
| Position within the organization | Regularly, repeatedly in each activity | | | |
| Relationships at the workplace | Long-term, permanent effect | | **Organizational symptoms** | **Other possible consequences** |
| Organizational structure, corporate culture, and climate<br>External impacts | | | High absence<br>High fluctuation<br>Low quality of work<br>Relationship problems | Significant increase in claims (compensation, higher insurance premiums)<br>Loss of competitiveness<br>Frequent and severe accidents |

hours, insufficient organization of work or poor or even dangerous physical working conditions. The World Health Organization (WHO) also lists bad relationships at the workplace, insufficient support from management and colleagues, harassment, discrimination or bullying as risk factors. Unclear job definition, insufficient salary, job insecurity and poor career growth also have a negative impact [15].

## 4. Result

Categories of the probability of occurrence of an adverse event - psychological workload, are expressed by the intensity (understood as a combination of frequency, or duration of exposure to stress hazard) of the stressor (Table 2).

The resulting risk matrix for the preventive assessment of mental occupational stress is shown in Table 2.

This matrix is inspired by a proposal by Taibi and colleagues in 2022 [16], who propose the application of a risk matrix for psychosocial risk assessment.

The finalization of this proposed matrix is the subject of further research. Research will also focus on the quantitative assessment of psychological distress using GSR sensors, which may also contribute to the development of a matrix for psychosocial risk assessment using appropriate coefficients developed from measurements. Based on the quantitative data obtained, the matrix will also be extended to include a time value for stress exposure. It will also be necessary to focus on the investigation of the economic and operational impact on the organization. The category of probability can be quantified using GRS sensors, which are part of the CAPTIV measurement system that the workplace has.

## 5.Conclusion

Mental health and psychosocial risks in the workplace have been recognized as occupational health and safety priorities in the European Union for at least two decades. The management of psychosocial risks is a current challenge for occupational health and safety (OHS) due to their impact on occupational stress and the rapid changes in the world of work. Effective management of psychosocial risks can be carried out through an integrated multidisciplinary model based on the risk management paradigm [14] and the standard for psychosocial risk management PAS 1010 [17].

Although the exact mechanism of action of mental stress on the development of MSDs is not known, their interrelationship is demonstrable. Therefore, it is necessary to address this issue and assess occupational stress, not only regarding physical stress, but also mental stress. The proposed matrix for preventive assessment of mental occupational stress can help to identify stressors in the workplace and subsequent implementation of appropriate safety measures for psychosocial risk management. Its practical application and possible modifications, leading to higher quality and effectiveness in practice, will be the subject of further research.

Table 2: Risk matrix proposed for the preventive assessment of mental occupational stress.

| ***Probability/ Consequence*** | ***Short-term increase in tension in the body, without harm to health*** | ***Possible illness, sick leave for more than 3 days*** | ***Depression, severe mental health conditi-ons, possible long-term health damage,mo-re than 42 days of sick leave or death*** | |
|---|---|---|---|---|
| Rare, unlikely | L | L | M | Level of risk: L – low risk M - medium risk H - high risk |
| Occurs regularly, likely | L | M | H | |
| Occurs permanently in the performance of an activity, very likely | M | H | H | |
| | | | | |
| **L – low risk** | There is a need to make sure that risk reduction measures are effective and sustainable in the long term, the risk needs to be communicated. | | | |
| **M – medium risk** | It is recommended that measures are planned to reduce the level of risk, e.g. by changing the job position or reducing the frequency of exposure to the stressor. | | | |
| **H – high risk** | Risk reduction measures must be implemented immediately, e.g. change in workplace ergonomics, organizational management changes, etc. | | | |

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