WORK-RELATED MUSCULOSKELETAL DISORDERS (WMSDs): RISK FACTORS, DIAGNOSIS AND PREVENTION

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ABSTRACT

INTRODUCTION: Impairments like musculoskeletal disorders (MSDs) that involve many days away from work affect negatively the productivity of businesses. Depending on the severity of the impairment, losses to businesses can be significantly high. Research to improve the understanding of the relationship between MSDs, carpal tunnel syndrome (CTS), related economic costs, lost productivity in businesses is essential given workplace injuries not only affect productivity but deteriorate the situation destabilizing the economic state of businesses. Millions of working days are lost due to work-related diseases all over the world.

AIM: The aim of this article is to analyze the main MSDs in regard to the diagnosis and the risk factors that lead to such conditions, and to outline some of the measures concerning the prevention of MSDs.

MATERIALS AND METHODS: Diagnosis, prevention and main risk factors of MSDs are analyzed based on literature search and vital statistics.

RESULTS: Among the major risk factors for MSDs are biomechanical, biobehavioral, psychosocial and organizational risk factors. The most common diseases of the musculoskeletal system are: myositis, tendonitis, paratenonitis, tendovaginitis, tendomyositis, stenotic tendo-ligamentitis, periarthritis, styloiditis, epicondylitis, spondylosis, spondyloarthritis and others. Isolated damages are less frequent. More frequent are the combined musculoskeletal and soft tissue disorders, such as myotendinitis, myotendinosis, myoinsertionitis, tendosinovitis, as well as interstitial lesions with vascular and neurological disorders: myositis, carpal tunnel syndrome with *n. medianus* lesion, scalenus syndrome – with nervous and vascular damages of the arm, etc. As work-related MSDs arise from multiple risk factors, a holistic preventive approach is needed. Preventive strategies need to be taken at three levels: primary prevention with a combined focus on the risk assessment process and implementation of technical, organizational and person-oriented measures; secondary prevention consists of targeting, early identification and intervention; and tertiary prevention aims to stimulate and facilitate the (multidisciplinary) return-to-work process of workers being absent from work due to an MSDs problem.

CONCLUSION: Early recognition of occupational MSDs by preliminary examination and regular check-ups is very important because medical treatment is unlikely to be effective once these impairments become long-standing. Cost effectiveness will be achieved by proper diagnosis, occupational MSD identification, and early onset of adequate rehabilitation followed by a short-term rehabilitation of the worker.

Keywords: *musculoskeletal disorders, MSDs, MSD risk factors, MSD prevention*

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INTRODUCTION

According to the United States (US) Bureau of Labor Statistics (BLS) definition for 2010 and prior years, musculoskeletal disorders (MSDs) “include cases where the nature of the injury or illness is sprains, strains, tears; back pain, hurt back; soreness, pain, hurt, except the back; carpal tunnel syndrome; hernia; or musculoskeletal system and connective tissue diseases and disorders, when the event or exposure leading to the injury or illness is bodily reaction/ bending, climbing, crawling, reaching, twisting; overexertion; or repetition” (1). From 1992 to 2010, MSDs accounted for 29-35% of all occupational injuries and illnesses involving days away from work in private industries. These workplace injuries cause disruption and sometimes involve days away from work. Injuries requiring time away from work are disabling injuries and adversely affect the productivity of businesses. Depending on the severity of these injuries losses to businesses can be significantly high. Research to improve the understanding of the relationship between MSDs, carpal tunnel syndrome (CTS), related economic costs, lost productivity in businesses is essential given workplace injuries not only affect productivity but deteriorate the situation destabilizing the economic state of businesses.

In 2010, the European Agency for Safety and Health at Work (OSHA) reported that musculoskeletal disorders were the most common work-related health problem in Europe, affecting millions of workers. They stated that the size of the problem is likely to increase as exposure to work-related risk factors for these conditions is increasing within the European Union (2). Estimates of the cost of these problems are scarce, however, where data does exist the cost has been estimated to be between 0.5% and 2% of the Gross National Product (GNP) (3). Looking at it over a one-year period, in 2000 OSHA reported that an estimated 350 million working days were lost due to work-related diseases in Europe (4).

In the UK, the total number of work-related musculoskeletal disorders (WRMSDs) cases (prevalence) in 2016/17 was 507,000 (new or long-standing) out of a total of 1,299,000 for all work-related illnesses, 39% of the total and a rate of 1,550 cases per 100,000 workers. The number of new cases of WRMSDs (incidence) in 2016/17 was 159,000, an the

incidence rate was 480 cases per 100,000 workers. An estimated 8.9 million working days were lost due to WRMSDs in 2016/17, an average of 17.6 days lost for each case with an estimated cost to the economy of above £6 billion. Work-related musculoskeletal disorders account for 35% of all working days lost due to work-related ill health. The affected area was mostly the upper limbs or neck (45%), backs (38%) and lower limbs (17%) (5). Working days lost per worker due to self-reported work-related musculoskeletal disorders showed a generally downward trend up to around 2010/11; since then the rate has remained predominantly flat.

AIM

The aim of the article is to analyze the main MSDs in regard to the diagnosis and the risk factors that lead to such conditions, and to outline some of the measures concerning the prevention of MSDs.

MATERIAL AND METHODS

Diagnosis, treatment, prevention and main risk factors of MSDs are analyzed based on literature search and vital statistics.

RESULTS

Risk Factors

Musculoskeletal disorders (MSDs) are defined as a group of disorders that affect the musculoskeletal system including the nerves, tendons, muscles, and supporting structures such as intervertebral discs (6). Although MSDs can occur as a consequence of intrinsic pathological processes or as a result of acute injuries from a one-time trauma, they are most commonly a result of cumulative trauma, that is, repetitive minor traumas and biomechanical stresses. Work-related musculoskeletal disorders describe disorders and diseases of the musculoskeletal system that are associated with cumulative traumas such as repetitive motion, excessive force, awkward and/or sustained postures, prolonged sitting and standing in the course of work (7).

According to Da Costa and Vieira “*risk factors* with at least reasonable evidence of a causal relationship for the development of work related musculoskeletal disorders include: heavy physical work, smoking, high body mass index, high psychosocial work demands, and the presence of comorbidities”

(7). Among the most commonly reported *biomechanical risk factors* leading to diseases of the musculoskeletal system are: mechanical overload, excessive repetition frequency, exposure time, awkward posture, accidents, and heavy lifting.

The *ageing* population gives rise to a particular challenge in ergonomics since the prevalence of MSDs generally increases with age; by their mid 30s most people have experienced their first episode of work-related MSD, usually in the form of back pain. As a person ages, their resistance to MSDs decreases, with the loss of tissue strength leading to higher severity and a more frequent onset of soft tissue damage (8,9). It has been shown in several studies that, due to reduced resilience, age is an important factor associated with MSDs (10-14). Musculoskeletal impairments are among the most prevalent and symptomatic health problems of middle and old age (15-17).

In some studies results have indicated that *females* are more predisposed than males, especially in the upper limbs (15-17). One notable exception is a survey by Widanarko et al. (2011) which did not find age differences across nine occupational groups ranging from heavy to light physical activity (18).

Many scientific studies have demonstrated an independent effect of *psychosocial risk factors* for MSDs (19). For back pain, the most consistent evidence of adverse health effects exists for high job demands (e.g. high workload and time pressure), low job satisfaction (overall satisfaction with the job) and low job support (colleagues and supervisor willingness to listen and provide assistance) (20). For neck and shoulder pain the most consistent evidence exists for high job demands. Evidence also exists that low job demands – jobs evaluated as monotonous or with insufficient use of skills – appear to be a risk factor for neck and shoulder pain (20).

The most common affected *professions* are: stonecutters (stonemasons), carpenters, tailors, carpet makers, weavers, bookbinders, shoemakers, builders, dentists, physical therapists, nurses (21), farmers and others (22-24).

Diseases

The most common diseases of the musculoskeletal system are: myositis, tendonitis, paratenonitis, tendovaginitis, tendomyositis, stenotic ten-

do-ligamentitis, periarthrititis, styloiditis, epicondylitis, spondylosis, spondylarthrititis and others. Isolated damages are less frequent. More frequent are the combined musculoskeletal and soft tissue disorders, such as myotendinitis, myotendinosis, myoinsertionitis, tendosinovitis, as well as interstitial lesions with vascular and neurological disorders: myositis, carpal tunnel syndrome with *n. medianus* lesion, scalenus syndrome – with nervous and vascular damages of the arm, etc.

Tendomyositis – a disease of the tendon or tendon-muscle transition. It occurs mostly in the middle third of the forearm.

Paratenonitis – trophic inflammatory process of the loose connective tissue that surrounds tendons devoid of shaped sheath. They are most common in the wrist and fingers extensors.

Stenosis syndromes:

Trigger finger – digital tendovaginitis stenosis, snapping finger, trigger digit or trigger thumb. Stenotic tendo-ligamentitis of the “annular ligaments” on the flexor side of the pineal gland of the metacarpal bones of the fingers – the tendon of the long flexor passes through the bifurcate tendon of the short flexor and the so-formed local hypertrophy produces results in difficulty flexing or extending the finger and the “triggering” phenomenon.

De Quervain's syndrome (De Quervain's stenosing tenosynovitis, de Quervain's tenosynovitis, radial styloid tenosynovitis) is an aseptic inflammation or tendinosis of the sheath or tunnel that surrounds the tendons of the extensor pollicis brevis and abductor pollicis longus muscles, moving the thumb away from hand-radial abduction. Disease of the short extensor and the long abductor of the thumb. Pain and swelling in the base of the thumb.

Stenotic syndrome of the carpal tunnel – (carpal tunnel stenosis, CTS) – distal impairment (damage) of *n. medianus* with irradiating hypoesthesia spanning the first three fingers and the lateral surface of the fourth finger of the hand, along with vegetative manifestations. Tinel's sign test and Phalen's sign test are positive.

Stenosis syndrome on n. ulnaris – tingling of the fourth and the fifth fingers of the hand, along with weakness of the adduction of the fifth finger. In the

severe stages it is accompanied by hypotrophy and hypotension of the thenar and the hypothenar.

Scalenus syndrome (thoracic outlet syndrome) – costoclavicular, hyperabduction and pectoralis minor syndrome are a group of syndromes primarily associated with arm symptoms. Neurovascular entrapment is thought to be caused by compression of the brachial plexus, subclavian artery and/or vein at some combination of the following sites: within the interscalene triangle, between the first rib and clavicle, and between the coracoid process and the tendon of the pectoralis minor muscle (Adson's Test).

Periarthritis:

Radial/ lateral epicondylitis – aseptic inflammation and degeneration of the common insertion site of the extensors: carpi radialis brevis, extensor digitorum communis, extensor digiti minimi and extensor carpi ulnaris, and part of supinator muscles, attached to the humerus in the region of the radial or lateral epicondyle of the humerus are established in tennis elbow syndrome. The radial epicondyle is the common origin of the forearm flexor and pronator muscles. Lateral epicondylitis manifests with Cozen's Test and chair test, etc.

Due to the long lever arm of the upper limb, the shoulder joint can be exposed to high forces. The tendons around the joint (rotator cuff) have a poor blood supply and are therefore more prone to degeneration with age than the tendons in other locations. Injuries and tendon inflammation can be common causes of MSDs in this area (25).

Shoulder periarthritis – dystrophic degenerative disease of the shoulder – tendons, tendon sheaths and the joint capsule are affected. It includes capsular, insertion, tendon-muscle damages and damages of the periarticular bursitis. A number of diseases are known by this name. They differ in their etiology and clinical manifestations, characterized by pain and impairment of the joints function, without affecting the articular bone structure. Among these are *subdeltoid bursitis*, *tendinitis of m. supraspinatus*, *tenosynovitis* of the long head of the biceps, *traumatic damage of tuberculum majus*. The anatomic substrate of the disease is the so-called second shoulder joint: superficially between the deltoid muscle and the acromion and in-depth – between the muscle-tendon cuff of the short shoulder rotators, that overcrosses

the tendon of the long head of the biceps. Some authors add to this group of diseases *adhesive capsulitis*, leading to fibrosis and joint capsule retraction, known also as “*frozen shoulder*”.

All processes develop in the narrow space between the acromion, processus coracoideus, and the coracoacromial ligament and tuberculum majus. In the presence of swelling in the soft tissues this space becomes relatively narrow and during abduction the tissues squeeze, followed by pain. With a hanging arm or an abduction of more than 150°, when the acromion is lifted due to the rotation of the blade, the space enlarges and the pain decreases. This is the test of the painful arm – a pain occurs between 45° and 160°.

Prevention

The *EU Framework Directive* of 12 June 1989 (Directive 89/391/EEC) sets out the EU regulatory framework for safety and health at work. Although it does not directly relate to the prevention of work-related MSDs, this Framework Directive contains basic obligations for employers and workers. It obliges employers to take appropriate preventive measures to make work safer and healthier, and introduces the principle of risk assessment as a key element in OSH prevention. It also stresses a hierarchy of preventive measures to be put in place after having assessed and evaluated the risks. These general prevention principles should also be taken into account when choosing strategies and preventive actions to tackle MSDs at the workplace.

In order to tackle MSDs at work, several preventive strategies can be taken. Three different levels of prevention can be used to categorize these strategies (26,27):

- ✧ *primary prevention* includes the risk assessment process, and technical/ergonomic, organizational and person-oriented interventions;
- ✧ *secondary prevention* involves the identification and health monitoring of workers at risks;
- ✧ *tertiary prevention* comprises return-to-work actions.

The risk assessment process forms the basis for the prevention of MSDs at the workplace. Risk assessment for MSDs can take place at two levels, as a primary or secondary prevention measure (28).

Ergonomic risk assessment is the systematic examination of all aspects of work, considering and evaluating the work-related and individual exposure of workers to physical and psychosocial risk factors for MSDs. The assessment also examines whether these risk factors can be eliminated and, if not, what preventive measures are, or should be, in place to control the risks. The risk assessment process allows to identify prevention priorities. Risk assessment should, if necessary, be supported by ergonomic experts.

Risk assessment can also be applied as a secondary prevention approach, by identifying workers at risk, ensuring the systematic monitoring of their health and investigate work-related causal factors. This should allow early intervention actions and prevent the chronification of acute MSDs.

Interventions at the organizational level can focus specifically on the improvement of: work processes, for example, by changing staffing levels, work cycle frequencies, working hours, or breaks between work tasks, for example by using solutions as job enrichment, job enlargement, or job rotation.

The aim of these types of interventions is often to reduce the exposure time to high physical load and/or increase recovery time. These organizational measures are generally adopted in tasks whose exposure level cannot be lowered due to the characteristics of the job or by applying technical measures (29).

From a tertiary prevention perspective, actions can be taken to support the reintegration (return-to-work, RTW) of workers being absent from work due to a subacute or chronic MSDs. RTW interventions should be initiated as early as possible (in the clinical stage of rehabilitation). A multidisciplinary and coordinated approach is required and can comprise measures for the evaluation and (ergonomic) adaptation of the work process or workplace, and individual support, training and psychomental education (28,30).

As work-related MSDs arise from multiple risk factors of biomechanical, biobehavioral, psychosocial and organizational nature, an integrated, holistic preventive approach is needed. Preventive strategies need to be taken at three levels: primary prevention with a combined focus on the risk assessment process and implementation of technical, organization-

al and person-oriented measures; secondary prevention targeting early identification and intervention; and tertiary prevention aiming to stimulate and facilitate the (multidisciplinary) return-to-work process of workers being absent from work due to an MSD-related problem. This integrated approach can be successful if it is embedded in a participatory environment and a strong prevention-oriented corporate culture.

CONCLUSION

The cost of occupational MSDs and CTS, which has been rising over the years, can help businesses to develop strategies to benefit from specific interventions that will reduce workplace MSDs and productivity losses (31-34). Moreover, it demonstrates a need for a uniform definition of MSD, which is to be followed by the workers compensation system and which will be ideal for the Bureau of Labor Statistics (BLS) when reporting cases of MSDs. Further research is needed in this area to investigate costs and incidence by industries and body parts and associate the costs with each event at the micro level (35).

Relevance to industry: The costs of MSDs are important to the industries too as a significant part of these costs are borne by the employers (36). Industries with higher prevalence of MSDs are affected more in terms of lost productivities due to the employees' days away from work because of MSDs. In cases of MSDs causing permanent disabilities, new hiring and training costs are also a part of the losses experienced by the employers (37).

Early recognition of occupational MSDs by preliminary examination and regular check-ups is very important because medical treatment is unlikely to be effective once these injuries become long-standing. Cost effectiveness will be achieved by proper diagnosis, occupational MSD identification, and early onset of adequate rehabilitation followed by a short-term rehabilitation of the worker.

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