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Review Article

Implement Successful Changes to Prevent Barriers to Musculoskeletal Diseases and how to Address these Barriers Systematically

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Abstract

The neuromuscular aspect of musculoskeletal disorders can be viewed as the capability of the neuromuscular demand to control motor activities through the synchronisation of muscle strength, muscle fibres recruitment patterns, proprioceptive feedback, and reflex activity. The muscular fatigue is associated with neuromuscular dysfunction, the development of musculoskeletal disorders (MSD), and occupational injuries. Advances in ergonomics/rehabilitation have brought various improvements and changes to the design of work and equipment, which has reduced the external forces required by workers to perform their tasks. In this review, a series of publications within the scope of this review, were searched for articles published in the past 30 years (1990 - 2020) from databases of EMBASE, IEEE Xplore Digital Library, Scopus, Web of Science, and Google Scholar. After the elimination, 39 articles are retained and classified to bring out the development knowledge in the field of musculoskeletal diseases in recent years. Through this review, we try to reveal various confounding factors that have become barriers to the prevention of musculoskeletal diseases, and try to systematically solve these barriers. Various factors that have a significant impact on causing musculoskeletal diseases have been discovered, such as posture, strength, frequency, and working hours.

Keywords: *Musculoskeletal Disorders; Neuromuscular Performance; Posture; Hand and Wrist Disorders*

Introduction

Over the past decade, researchers have renewed their attention in considering patients with neurological and/or musculoskeletal disorders (MSDs). The neuromuscular aspect of MSD can be viewed as the capability of the neuromuscular system to control motor activities through the synchronization of muscle strength, muscle fibers recruitment patterns, proprioceptive feedback, and reflex activities [1]. Numerous studies have reported that force exertions of more than 15 - 20% of an individual's maximal voluntary contractions (MVC) may be associated with musculoskeletal disorders [2]. Muscle endurance also plays a significant role in the risk of accidental injuries and work-related musculoskeletal disorders (WMSDs). Those with high endurance are less likely to have an accident. This is because fatigue gives to mental failure and interferes with muscle strength and synchronization, increasing the threat of mishaps and injuries [3]. Actions containing repetitive forces are commonly found in the workplace and often contribute significantly to poor muscle performance [4].

The muscular fatigue is associated with neuromuscular dysfunction, the development of musculoskeletal disorders (MSD), and occupational injuries [5]. Upper limb musculoskeletal pain and injury catalyzes researchers in identifying key risk factors involved in various tasks. However, advances in ergonomics/rehabilitation have brought various improvements and changes to the design of work and equipment, which has reduced the external forces required by workers to perform their tasks. Various physical risk factors in the workplace that lead to a decrease in muscle performance include repetitive movements, forceful exertions with partial chance of recovery, awkward postures [6], mechanical pressure, and hand arm vibration [7]. An awkward posture of the elbow may be cause due to extreme forearm pronation and/or supination, especially if the movement is repetitive. As a result, these physical factors can cause pain/discomfort, reduced muscle strength/endurance/ power/ranges of motion, may be leading to serious injuries. Task-specific factors, including gender, age, body mass index (BMI), discomfort, medical history, experience and the nature of the job were identified as factors affecting fatigue-related performance decline in adults [8].

Literature Search Methodology

In this review, a series of publications within the scope of this review, were searched for articles published in the past 30 years (1990 - 2020) from databases of EMBASE, Scopus, Web of Science, and Google Scholar. The following combinations of keywords were used: whole body vibration, vibration therapy, vibration intervention, musculoskeletal disorders, work-related musculoskeletal disorders, elbow and wrist disorders, arm vibration, posture, gender, frequency and duration, rest interval, and musculoskeletal disease-related costs. In addition, some articles published before 1990 are cited to present this review in more informative way. Among the 178 studies collected, the titles and abstracts were carefully reviewed to exclude articles that are unique to medicine but not related to musculoskeletal disorders. After the elimination, 39 articles are retained and classified to bring out the development knowledge in the field of musculoskeletal diseases in recent years.

Musculoskeletal disorders

Introduction

Musculoskeletal disorders (MSD) is a very important and common problem, especially for industrialized countries [9], particularly upper limb disorders and other general risk factors: strength, forearm and wrist posture, are related to their causality [2]. In several countries, work-related MSD are the second most common challenge in medical support [10]. Musculoskeletal disease (MSD) is multifaceted in nature and caused by many confounding factors [11].

The upper limb work-related MSD and injury can be a facilitator for researchers in order to define the various work-related risk factors. However, there have been various improvements and changes in work and equipment designs due to advancement in the field of ergonomics, which led to a decrease in the strength essential to perform any task by the workers. According to reports, forearm pronation has also been shown to reduce grip strength; however, the effect of supination is less clear [12]. Various occupational risk factors foremost cause of MSDs is forceful exertions with partial chance for retrieval [13], poor and awkward posture, and vibration of hand arm [14], to name a few.

Types of work-related MSDs

One of the foremost ergonomic concerns is to identify factors that affect comfort and discomfort, improvement in working environment, and improve production for effective use. As a result, the ergonomics of hand tools pose a significant comfort problem and discomfort

is often evaluated as a predictor of musculoskeletal disorders. Work-related musculoskeletal diseases are injuries, diseases, or dysfunctions caused by occupational or non-occupational tasks that affect muscles, bones, nervous system, tendons, ligaments, joints, cartilage, and intervertebral discs, including poor posture, high frequency of effort [15]. The most common types of WMSD are defined as follows.

Elbow musculoskeletal disorders (Epicondylitis)

Although each body joint is significant, the elbow joint is of different importance because of its application in most manual tasks. Tendinitis is a major injury to the elbow joint and causes inflammation or damage to the tendons that connect the muscle to the bone. However, this also occur due to awkward posture or excessive use during occupational repetitive tasks. The tennis elbow is an injury due to overuse in the lateral part of the elbow, but more precisely to the extensor tendon that starts from the lateral epicondyle. This is often called lateral epicondylitis. It is a condition where the outer part of the elbow becomes painful and sensitive due to fatigue in the muscle fibres. Epicondylitis has also been associated with work requiring sustained effort, such as the installation of wall panels, roofing, masonry, foundries, furniture manufacturers, paper products manufacturers and butchers [16].

Hand/wrist musculoskeletal disorders

The most significant functions of the hand/wrist while working in any industry or in day-to- day life activities are eating, gripping, and the manipulation of the objects [10]. In several industries, repetitive hand grip tasks are essential, as the labours frequently accomplish the similar task at low intensities for extended durations, with a small span of rest [17]. The various injuries associated to hand/wrist dysfunction, are more discussed below.

Carpal tunnel syndrome

Since the early 1980s, the number of cumulative injuries for which compensation has been awarded has increased steadily [18]. These injuries affects the joints, tendons and nerves. Among the cumulative injuries, carpal tunnel syndrome (CTS) is the most prevalent because of its prevalence in certain industries. CTS is due to the inequality between professional (high intensity, high repetition levels, extreme joint angles, vibration and shock during jobs) or super-professional nature (sports) biomechanical constraints, but it also depends on other functional capabilities (physical status, age, gender, lifestyle, etc). This pathological approach has many consequences for individuals (occupational disability, medical care) and employers (loss of productivity and sick leave) [18].

Hand/wrist tendinitis

In any industry work or daily life activities, the most important functions of the hand/wrist are eating, grasping, and manipulating objects with force [10]. In various industries, repetitive grasping tasks are inherent because labours frequently accomplish the similar tasks with low intensity and longer periods of time, with short rest periods, which often leads to hand tendinitis. Hand tendinitis is the tendency of tendons to swell due to tendon fatigue. This usually occurs on fingers and wrists, causing tightness, soreness, irritation, discomfort and pain.

Hand arm vibration syndrome

The main factors associated with hand arm vibration (HAV) are often due to the use of vibrating hand tools such as pneumatic hammer, drills, motorized chain saws and grinders. In HAV, the vibrations are transmitted directly from the vibrating tool to the hands and arms of the person holding the tool. Occupational workers who apply a strong and repetitive grip force on vibrating tools may develop circulatory,

neurological or musculoskeletal disorders resulting in muscle weakness, fatigue, arm and shoulder pain, and vibration induced white fingers [13].

Factors associated with MSDs

Many factors have been related with MSDs, such as repetitive motion, forceful exertion, awkward and/or sustained postures, prolonged sitting and standing [19]. WMSDs, mainly in the upper extremity, pose a very high risk in the occupational industry, with high costs. In addition, several studies have also shown that work-related risk factors causing MSDs are due to high levels of force and repetitive movements with less change in recovery, awkward postures [6] and hand arm vibration [14].

Posture

The postures adopted by the workers during the tasks performed are of great importance. Good posture provides worker comfort, increased productivity, and protection from injury, while poor postures and/or uncomfortable conditions have been documented as high risk factors for WMSDs [13,20,21]. Occupations with awkward postures, showed a higher prevalence of WMSDs.

Wrist/hand upper

Upper limb complaints are utmost often related with deviated postures, i.e., flexion and/or wrist extension, radial or ulnar wrist deviation. In addition, there are also other disorders, such as De Quervain's syndrome and epicondylitis, which have also been linked with radial or ulnar wrist deviations [13]. Awkward postures of the wrist may be due to poor layout of the workplace, shape and orientation of the handles of the hand tool, resulting in many cumulative traumatic disorders (CTDs) of the upper limbs [22].

Forearm

Silverstein., *et al*. [26] found that in several industries, workers used pronation and supine forearm posture during repetitive movements and forceful exertion, resulting in forearm and elbow injuries, causing lateral epicondylitis. Mukhopadhyay., *et al*. [23] examined the effects of forearm rotation on perceived discomfort. They found that compared with supine forearm or neutral posture, 45° (elbow flexion) had greater discomfort for forearm pronation. However, due to excessive pronation and/or supination of the forearm, awkward postures may occur, mainly when the movements are very repetitive [23].

Elbow/upper arm

Herberts., *et al*. [24] examined the effect of elbow flexion combined and reported an increase in localized fatigue in muscle fibres when angle of abduction increased from 45° to 90°. Kilbom and Persson [25] established the relationship between upper arm abduction and the onset of WMSD symptoms. In addition, they reported that in the electronic manufacturing sector, workers must remain seated with the flexion of the neck and arms raised, exposing workers to a high risk of shoulder and upper limb disorders. Therefore, it can be argued that factors such as the postural shoulder angle associated with the magnitude of the applied force have shown influence on shoulder muscle fatigue. However, further research was needed to prevent upper limb WMSDs associated with upper extremity deviation.

Force

In addition to awkward posture, increased grip strength and high repetition rate have also been reported as work-related risk factors [26]. In various industries, repetitive grasping tasks are inherent, because labours repeatedly perform the identical tasks for a prolonged

time and with low intensity, with short rest periods [17], leading to many types of WMSDs. The increase affects muscles, tendons, nerves and other musculoskeletal structures [19].

Frequency

Repetitive tasks, which represent a possibility of emerging musculoskeletal disorders, are classified according to their extremely repetitive activities and often short work cycles. Silverstein., *et al*. [26] stated that a very high repetitive exposure, with a cycle duration of less than 30 seconds or performed by the similar actions for further 50% of the total cycle time, was linked with an augmented risk of developing hand-wrists disorders. Exposure to repetition alone increases the risk of CTS and the combination of repetitiveness, forceful exertion and awkward posture leads to hand and wrist problems [19]. Several studies [27,28] have examined the risk of development of WMSDs because of a high exertions level per minute and reported that 10 exertions gave better results and a lower discomfort score compared to 20 exertions per minute.

Work duration/rest

In literature it has been reported that work duration, exertion cycle time and rest periods plays significant part in decreasing the risk of WMSDs [28-31]. Christensen., *et al*. [29] proposed that the work- to-rest pattern in the duration of the work cycle may be a significant factor in evaluating the risk of MSD development caused by repetitive task. Work cycle time of less than 30 seconds has been defined as a limit for repetitive task identification work at high risk [26].

Data related with WMSDs

Musculoskeletal disorders (MSD) is a very important and common problem, especially for industrialized countries [9], particularly upper limb disorders and other general risk factors: strength, forearm and wrist posture, are related to their causality [2]. Putz-Anderson [2] stated that an increase in the number of jobs in services and high technology, an aging staff and a reduction in staff turnover were the work-related factors related with development of MSDs among U.S workers. In the United States, WMSDs have reached approximately 15 to 20% of the labour each year [32]. In 1999, about 246,700 WMSDs were informed to the US Bureau of Labour Statistics [33] and involved the majority of occupational injuries and illnesses. Among staff employed in government industries, upper extremity WMSDs showed 46% of the neck pain, 66% of the shoulders, 29% of the elbow and forearm, 24% of the wrist and 42% of the hand [34], with occurrence of 66% in the hand/wrist region. In France, upper limb MSDs were found to account for about 2/3 of WMSDs [35]. The development of WMSDs is growing very rapidly in the United States and that the incidence rate has increased from less than 5% per annum in 1981 to 30% per annum in 1994 [24].

In addition, 30% of non-manual British workers informed discomfort to the neck or upper limbs [36]. In Taiwan, the occurrence of neck and shoulder discomfort was 14.8% and 16.6% respectively in a survey of 17,669 workers [37]. WMSDs of the shoulder are very common disorders in manufacturing and construction industries. Great prevalence and occurrence rates have been reported among workers involved in construction due to WMSDs, as they were exposed to physical material transferring around the world [38]. Comprehensive physical investigations of 146 women workers in extremely repetitive industries were conducted and the result showed forearm dysfunction in 23% of workers [39].

Conclusion

Through this review, we try to reveal various confounding factors that have become barriers to the prevention of musculoskeletal diseases, and try to systematically solve these barriers. Various factors that have a significant impact on causing musculoskeletal diseases have been discovered, such as posture, strength, frequency, and working hours.

Conflict of Interest

None to report.

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