Interventions commonly used to prevent work-related musculoskeletal disorders among healthcare workers

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Abstract

Purpose – The purpose of this paper is to review the prevalence and risk factors of work-related musculoskeletal disorders (WMSDs) among healthcare workers (HCWs) in order to ascertain the occupation with the highest susceptibility to WMSD in the health sector. This paper will also review the effective interventions which have been used to prevent WMSDs among HCWs.

Design/methodology/approach – This study is a literature review of 11 papers related to the prevalence and risk factors of WMSDs and 12 papers about the interventions being used to prevent WMSDs among HCWs. The papers were retrieved from respectable databases such as PubMed, Science Direct, Google Scholar and E-Thesis.

Findings – Nurses belong to the major group of HCWs who had the highest prevalence of WMSDs compared with other health professionals and other hospital workers. Although there are several interventions being commonly used to prevent WMSD risk factors, some interventions were unsuccessful in the prevention of WMSDs in healthcare tasks. Therefore, it is necessary that future research focuses on the tasks of HCWs that are WMSD risk factors and tries to innovate or redesign ergonomic workstations to prevent those risk factors.

Originality/value – The expected benefit of this study is to motivate ergonomists to provide appropriate and innovative interventions to ensure health and safety for nurses and other HCWs.

Keywords Work-related musculoskeletal disorders, Healthcare workers

Paper type General review

Introduction

Musculoskeletal disorders (MSDs) are disorders that occur in the muscle, tendon, ligament, bone, joint, intervertebral disc and skeleton of the whole body. In general, diagnosis of MSDs caused by work is accepted by an agreement in each country. In 2007, the Ministry of Labor in Thailand, classified MSDs as being within the group of occupational diseases. The Bureau of Policy and Strategy in Thailand's Ministry of Public Health reported an increase in the morbidity rate of work-related musculoskeletal disorders (WMSDs) from 121.93 per 100,000 persons per year in 2015 to 135.26 per 100,000 persons per year in 2016. Due to this rapid increase, there is an urgent need for innovation in ergonomic interventions to prevent an increasing health problem among the workforce[1].

WMSDs are one of the most common health problems among healthcare workers (HCWs). Previous studies indicated that HCWs, whose responsibilities include carrying, transferring or

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relocating patients, regular forward bending of the whole body and prolonged standing, were exposed to a high risk of WMSDs in the neck, lower back and knee regions[2, 3]. Moreover, a study by Yasobant and Rajkumar[4] showed that HCWs working in a prolonged sitting, standing, awkward posture or cramped positions put employees at a major risk of WMSD. There are personal factors to WMSDs as well. Mirmohammadi *et al.* also reported that female HCWs were more prone to develop WMSDs than male HCWs and that the body mass index of the HCWs was also related to WMSDs[2]. Specifically, nurses had the highest prevalence of WMSDs compared to dentists and physical therapists, while laboratory technicians and physicians had a lower prevalence[5]. Also, Manmee *et al.* reported that Thai nurses had the highest prevalence rate of WMSDs when compared to support staff in hospitals[6]. Although there is research regarding the prevalence and risk factors of WMSDs in HCWs, there are no cross comparisons between each occupation in the healthcare sector.

Therefore, this paper reviews the existing literature on the prevalence, risk factors and prevention of WMSDs among HCWs to find the occupations that have the highest prevalence and related risk factors of WMSDs. The emphasis is on workstation redesign and innovative approaches to reduce or to prevent WMSDs among HCWs according to their job characteristics and postures[7–17].

Methods

Papers published between 1990 and 2017 were selected from respectable databases such as PubMed, Science Direct, Google Scholar and E-Thesis. Keywords used to search for these papers included: WMSDs, healthcare workers, physicians, dentists, physical therapists, pathologists, laboratory technicians, allied health professions, nurses, hospital workers, ergonomic design, workstation, guidelines and scientific tools such as electromyography (EMG), 3-D electromagnetic tracking system, lumbar motion monitor (LMM) and anthropometric measurements. Inclusion criteria included studies that showed prevalence and risk factors of WMSDs in each body part. In total, 11 papers about the prevalence and risk factors of WMSDs among HCWs were selected for review. In total, 12 additional papers were reviewed to explore the guidelines and the innovative interventions that can reduce or prevent the risk factors of WMSDs in each body part. Studies that report a result of the intervention suggested following a self-report questionnaire survey were excluded.

Results

There are many groups of HCWs in the hospital setting including physicians, dentists, nurses, physical therapists, laboratory technicians or allied health professions. Almost all HCWs had reported problems that are categorized under WMSDs. The common WMSDs among HCWs included the upper and lower back, neck, shoulder and hand/wrist. Risk factors were repetitiveness, awkward postures, working in the same position for long periods and bending/twisting of the back for physicians. Eye care physicians experienced a higher prevalence of WMSDs in all body parts compared to family medicine physicians[18]. Dentists were also found to work with prolonged periods of time sitting in inadequate ergonomic working environments. That is why dentists have the highest prevalence of overall WMSDs (92 percent)[19]. Additionally, physical therapists and allied health professions who work in laboratories work with prolonged use of medical devices such as microscopes and sonographs. WMSDs among physical therapists were mainly in the lower back (46.5 percent), shoulder (45.2 percent) and neck (44.9 percent)[20], while the overall WMSDs among other allied health professions such as microscope workers, pathologists and radiologic technologists were 62, 76 and 88.9 percent, respectively[21–23]. Among nurses, the overall prevalence of WMSDs was about 55.6–91.7 percent. When focusing on the body part, nurses have the highest prevalence in the shoulder (12.6–64.4 percent) followed by lower back (44.1–58.5 percent), upper back (16.8–44.9 percent) and hand/wrist (16.2–36.1 percent) because

they work with more tasks requiring patient handling and transfer or lifting of patients/equipment than other HCWs[3, 24, 25]. Table I shows the prevalence and risk factors of WMSDs among HCWs in each body part from the selected papers.

Regarding interventions, the redesign of workstations and guidelines were used to prevent risk of WMSDs. These interventions vary according to the HCW's working postures and job characteristics. From previous research, the scientific tools used to measure between, before and after intervention included: EMG, 3-D electromagnetic tracking system, LMM and anthropometric measurements. For the subjective tools, they used modified WMSD questionnaires, satisfaction forms and comfort scales. Results show that the interventions not only reduce muscle activity, but HCWs were also satisfied when they used the new workstation. For example, an ergonomic dentist chair with an arm rest and thoracic support was used to reduce WMSDs in the upper limb[7]. Microscope workstations with arm support also reduced WMSDs in allied health professions who work in laboratories when analyzed by EMG[9, 10], while the self-report questionnaires showed satisfaction with the new workstation[10]. Since nurses show the highest prevalence of WMSDs when classified by body region, there were many interventions recommended. However, from previous research, interventions cannot prevent all risks of WMSDs in nurses[11]. Table II shows the workstation and guidelines that previous research recommended to use for the prevention of WMSDs among HCWs.

Discussion

Table I shows that WMSDs among HCWs occurred primarily in the upper body part including lower and upper back, neck and shoulder, while Table II shows the interventions and guidelines that help to prevent WMSDs among HCWs. It must be noted that all interventions and guidelines were designed by considering the job characteristics that include risk factors of WMSDs.

A previous study[18] found that physicians were exposed to patients in the same working posture resulting in repetitive work, awkward positions and bending or twisting the back. Similarly, dentists, worked with repetitive head rotation, spine rotation and prolonged leg bending resulting in dentists complaining about WMSDs[26]. Furthermore, bad working habits and uncomfortable physical postures are the causes of MSDs, discomfort and fatigue among dentists[27]. Regarding these working postures, Haddad *et al.*[7] found that the ordinary dentist chair was a risk factor that caused WMSDs in the trapezius muscle among dentists so they designed an ergonomic dentist chair with an arm rest and thoracic support. The result showed that the ergonomic dentist chair reduced EMG activity in the trapezius.

Among laboratory technicians, Fritzsche *et al.*[21] found that the prevalence of WMSDs in pathologists who are microscope users was 76 percent, whilst pathologists with visual problems, mainly myopia, was at 90 percent . Jain and Shetty[22] indicated that 94 percent of microscope users in the laboratory reported some visual problems during microscope use, while WMSDs of microscope workers were reported in the neck, back, shoulder and wrist and hand regions, respectively. There are many interventions and guidelines to prevent WMSDs in laboratory technicians, i.e., the guidelines of Mitchell *et al.*[14], and the Centers for Disease Control and Prevention[15]. Also, the Occupational Safety and Health Administration guidelines for microscope workers suggested that the standardized microscopes should be ergonomically designed as shown in Table II[16].

There are many studies aimed at reducing the problems of WMSDs in laboratory-based microscope workers by redesigning new ergonomic workstations. For example, in 2002, Kofler *et al.*[9] designed a new microscope workstation by using a table fitted with unique adjustable slanting "wings," also allowing the forearms to be angled at 90^{o} at the elbow and to rest on the surface while operating the control knobs and sitting on the ergonomic chair

Table I.
WMSDs and risk factors among HCWs reported in the reviewed papers

Study	Year	Country	Population	Sample size	Study design	Prevalence (%) Overall	Lower back	Upper back	Neck	Shoulder	Hand/ Wrist	Risk factors
Kitzmann *et al.*[18][a]	2011	USA	Eye care physicians	94	Cross-sectional study		26	19	46	11	17	Repetitive work, awkward positions, working in the same position for long periods, bending/twisting the back
Kitzmann *et al.*[18][a]	2011	USA	Family medicine physicians	92	Cross-sectional study		9	12	21	11	7	
Kierklo *et al.*[19]	2011	Poland	Dentists	220	Cross-sectional study	92	35	47	47	20	18.3	Working duration and working hours, standing work posture, no rest breaks, limited ergonomics in the work environment of dentists
Weerapong *et al.*[20]	2008	Thailand	Physical therapy students	1,784	Cross-sectional study		46.5	26.2	44.9	45.2	15.1	Prolonged lecture hours, physical therapy practice, sports activities, sitting in the same position for long periods
Fritzsche *et al.*[21]	2012	Switzerland	Pathologists	163	Cross-sectional study	76	39.8	45.5	78	60.2	27.6 (arm)	Gender (female), more weekly working hours, hours spent at the computer
Jain *et al.*[22]	2014	India	Microscope users in medical laboratory	50	Cross-sectional study	62	61.3		83.9	9.7	9.7 (hand) 6.4 (wrist)	Prolonged working hours and anxiety during or after microscope use, using microscope for 11–15 years, using microscope for more than 15 years, using microscope for more than 30 h/week
Lamar[23]	2004	USA	Radiologic technologists	160	Cross-sectional study	88.9	73.3		52.2	36.7	31.1	Patient positioning, transporting equipment, sonographer's posture
Tinubu *et al.*[3]	2010	Nigeria	Nurses	160	Cross-sectional study	84.4	44.1	16.8	28	12.6	16.2	> 20 years of clinical experience, working in the same positions for long periods, lifting or transferring dependent patients, treating an excessive number of patients in one day
Sinsongsuk *et al.*[24]	2006	Thailand	Nurses	356	Cross-sectional study	55.6	33.4	19.4	15.5	19.8	18.4	Not having regular exercise, having managerial tasks, working in awkward posture and lifting objects between 10–25 kg
Jin *et al.*[25]	2011	Thailand	Nurses	248	Cross-sectional study	91.7	58.5	44.9	20	64.4	36.1	Cumulative of employment, documenting patient records, making bed with patient in it, preparation of equipment, job control and social support

Note: [a]30-day prevalence

Table II.
Interventions used to reduce WMSDs among HCWs reported in the reviewed papers

Study	Year	Country	Population	Sample size	Study design	Tools	Intervention	Conclusion/ Recommendation
Haddad *et al.*[7]	2012	Iran	Dentists	12	Experimental study	Electromyography (EMG)	Redesign an ergonomic dentist chair with arm rest and thoracic support	Intervention can reduce WMSDs in upper extremities
Murphey and Milkowski[8]	2006	USA	Sonographers	22	Experimental study	Electromyography (EMG)	Provide forearm support to worker when using their instruments Leading to working posture being changed to near natural position	Intervention can decrease WMSDs
Kofler *et al.*[9]	2002	Austria	Medical students, residents, senior doctors	12	Experimental study	Electromyography (EMG)	Design a new microscope table fitted with unique adjustable slanting "wings" Allowing the forearms to be angled at 90° at the elbow and to rest on the surface Operating the control knobs and sitting on the ergonomic chair with support for the lower back	Intervention can reduce mean EMG in neck, shoulder, upper arm, forearm, back
Sillanpää *et al.*[10]	2003	Finland	Microscope workers	10	Experimental study	Electromyography (EMG)	Forehead and upper extremities support Good sitting posture with chair adjustments and variation in posture	Intervention can reduce mean EMG in neck and shoulder Microscope that workers were happy to use
Nelson *et al.*[11]	2003	USA	Nurses	134 (63 intervention and 71 non-intervention)	Experimental study	Electromyography (EMG) 3-D electromagnetic tracking system Questionnaires Anthropometric measurements Perceived by comfort scale	Bathing patient in bed (top side) Bed height adjusted according to caregiver's needs Use new air mattress	Reduction in lumbar spine moment 60% Reduction in left shoulder movement 50% Reduction in lumbar force 59%

(*continued*)

Table II.

Study	Year	Country	Population	Sample size	Study design	Tools	Intervention	Conclusion/ Recommendation
							Bathing patient in bed (under side) Bed height adjusted according to caregiver's needs Use new air mattress	No significant improvement when bathing under side
							Making an occupied bed Bed height adjusted according to caregiver's needs Use new air mattress	Not significant
							Dressing a patient in bed Bed height adjusted according to caregiver's needs Use new air mattress	Not significant
							Transferring from bed to stretcher Elevate chair that facilitated lateral transfers by converting from chair to stretcher Use friction-reducing device to minimize force requirements	Redesigned task perceived by caregivers as more comfortable External applied forces reduced 48% Erector spinae activity reduced 25% Shoulder muscle activity reduced 33%
							Transferring patient from bed to wheelchair Elevate ceiling-mounted lift for this task, assumed that sling was incorporated into patient clothing or bedding (new technology in development)	Intervention perceived by caregivers as more comfortable Lumbar spine movement reduced by 54% Left shoulder movement reduced by 69% Right shoulder movement reduced by 45% Lumbar force reduced 58%

(*continued*)

Table II.

Study	Year	Country	Population	Sample size	Study design	Tools	Intervention	Conclusion/ Recommendation
							Transferring patient from bed to geri-chair Elevate chair that facilitates lateral transfers by converting from chair to stretcher Use friction-reducing device to minimize force requirements of the task	Redesign perceived by caregivers as more comfortable Lumbar spine forces reduced 36% Erector spinae activity reduced 25% Shoulder muscle activity reduced 45%
							Pulling patient up in chair Test recline and incline operation of occupied chair that converts to stretcher	Redesign perceived by caregivers as more comfortable
							Pulling patient up to head of the bed Head of height adjustable bed tilted 10 degrees downward Patient's knees bent Use of innovative beds with shear less pivots would eliminate this task by preventing patients from sliding down in bed	Shoulder movements reduced by 40% External applied force reduced by 31%
							Applying anti-embolism stockings Bed height adjusted according to caregiver's needs Caregiver approached task from foot of bed, thereby improving body mechanics	Lumbar movement reduced 23% Left shoulder movement reduced 29% Erector spinae activity reduced 20% Shoulder muscle activity reduced 27%

(*continued*)

Table II.

Study	Year	Country	Population	Sample size	Study design	Tools	Intervention	Conclusion/ Recommendation
Weiner *et al.*[12]	2017	Israel	Nurses	48	Experimental study	Lumbar motion monitor (LMM)	Repositioning a patient in bed (move to head of bed) Ergonomically advantageous assistive device including Sliding sheet Regular cotton sheet Carrier	Use of sliding sheet satisfied by nurses Using assistive devices have a significant influence on the back, upper limbs, shoulders and neck loading
Goyal *et al.*[13]	2009	UK	Workers in radiology department	–	–	Guideline of an ergonomically designed workstation and reporting room in radiology department	Use the guideline to design a good workstation in both working environment and working condition that are the factors related to WMSDs	Work under guidelines can reduce the risk factors of WMSDs
Mitchell *et al.*[14]	Cited 2016	USA	Laboratory workers	–	–	Recommendation of laboratory ergonomics	The neutral posture could be set as the guideline for the laboratory ergonomics including Ears over shoulders Shoulders in line with the hips Forearms 90° angle or more from the upper arms, wrists straight (not bent, angled, or twisted) Shoulders relaxed Elbows hanging close to the sides Head is balanced on spinal column not tilted or rotated to any side	Neutral posture can prevent WMSDs
Center for disease control and prevention (CDC)[15]	Cited 2016	USA	Microscope workers	–	–	Recommendation of microscope use-to prevent musculoskeletal disorders	The microscope workers should not use the microscope more than 5 h/day, and should take frequent short breaks from microscopy work	Recommendation can prevent the risk factors of WMSDs

(*continued*)

Table II.

Study	Year	Country	Population	Sample size	Study design	Tools	Intervention	Conclusion/ Recommendation
Occupational Safety and Health Administration (OSHA)[16]	2011	USA	Microscope workers	–	–	OSHA fact sheet on laboratory safety ergonomics for the prevention of musculoskeletal disorders	Recommendation 1. Sitting near the workstation 2. Do not lean on the hard edges 3. Use arm rest to support forearms and prevent forearms on the edges 4. Keep elbows close to the body 5. Adjust workstation for upright head position 6. Do not bend the neck in microscope session 7. Adjust eyepieces or mount the microscope on a 30° angle stand for easier use 8. Keep scopes repaired and clean 9. Use a microscope with work rotation between the colleagues, if possible 10. Take a break every 15 minutes by closing the eyes or focus on something such as green garden in the distance, walking around every 30–60 min	Recommendation can prevent the risk factors of WMSDs
Helander *et al.*[17]	1991	USA	Microscope workers	–	–	Recommendation about planning and implementation of microscope work	The way to develop and improve microscope work is to Design the better ergonomic microscope workstations and microscopes More efficient product design Use the microscopes with the monitor Using microscope training Work rotation Limitation of overtime work	Recommendation can prevent the risk factors of WMSDs

with support for the lower back. The result showed that the new design of an ergonomic workstation can reduce EMG activities in the microscope workers' muscles.

Another example is the study of Sillanpää *et al.*[10] who designed a new ergonomic microscope table with forearm support for microscope workers. They found that the new ergonomic microscope table reduced EMG activity of muscles in the neck and shoulder, and that microscope workers in their study were satisfied to work with the new ergonomic microscope table. In 2010, Sillanpää and Nyberg[28] recommended the design of microscope workstations that should have forehead and support of the upper extremities and good sitting postures with chair adjustments and variation in posture. Helander *et al.*[17] also recommended that using ergonomic microscope workstations and introducing training programs can reduce visual problems and muscular fatigue in microscope workers.

Similarly, workers in the radiology department spent more time in front of a computer monitor. Factors including lighting, temperature and ventilation, special circumstances, noise, personal factors and training were found to be related to repetitive strain injuries. In 2004, Lama[23] reported that the radiology technologists reported a prevalence of musculoskeletal symptoms in the back, right hand/wrist and dominant hand/wrist, right shoulder and dominant shoulder. For guidelines and interventions to reduce WMSDS in workers in the radiology department, Goyal *et al.*[13] discussed the key features of an ergonomically designed workstation and reporting room in the radiology department that can be used as the guideline to design a good workstation because the working environment and working conditions were also found to be related to WMSDs. Specifically, regarding sonographers in the radiology department, Murphey and Milkowski[8] studied about an adjustment of sonographer scanning postures. They indicated that the EMG activities of the muscle in the shoulder and forearm were decreased when the sonographer changed their working posture to near natural position and used the support under the forearm when they used their instruments.

Among physical therapists who work with patients with physical problems, they were found to work with awkward postures in their physical therapy practice. Weerapong *et al.*[20] reported that the highest prevalence of WMSDs among Thai physical therapy students was in the lower back followed by shoulder, neck, upper back and wrist/hand. This is because Thai physical therapy students must work in prolonged seating positions during their physical therapy training. Bae and Min[29] reported that WMSDs among the physical therapists were mostly found in the shoulders followed by hand and back, neck, arm, hip and knee, respectively. Moreover, a previous prospective cohort study with one-year follow-up[30] reported that the incidence rate of WMSDs among physical therapists was 20.7 percent.

Similar to physical therapists, nurses have to take care of patients with physical disabilities and patients who cannot help themselves. Nurses in particular are required to take care of all patients in all units. Furthermore, previous studies[5, 6] show that nurses were at the highest risk of developing WMSDs when compared with other healthcare workers and support workers. Tinubu *et al.*[3] indicated that the 12-month period and point prevalence rate of WMSDs in any part of the body among Nigerian nurses were 78 and 66.1 percent, while most WMSDs occurred in the lower back, neck and knees, respectively. Thai nurses also had a high prevalence rate of WMSDs because they were exposed to physical workloads, non-neutral working postures and a psychologically demanding workload. Sinsongsuk *et al.*[24] reported that the 12-month prevalence of WMSDs among Thai nurses was about 55.6 percent. Common areas of the body that were found to be related to WMSDs were lower back 33.4 percent, shoulders 19.8 percent and upper back 19.4 percent. In 2011, Jin *et al.*[25] reported that 92 percent of Thai nurses had WMSD symptoms in their body a 12-month period during which time 54 percent of them visited a physician or physical therapist, while common injury areas related to their work were lower back, shoulders and neck. The top 3 major hazards of their workload were nursing management, repositioning patient in bed and preparing and distributing medication, while

the top 3 major hazardous working postures were neck/shoulder in non-neutral posture, bending and twisting waist in awkward posture and prolonged standing.

Literature reviews[24, 25, 31] showed that lower back pain was a major cause of WMSDs among nurses. Based on three hazard categories developed by Nelson *et al.*[32], the author studied patient handling tasks for nurses. They focused on the ten high risk tasks in order to redesign new working postures and used this tool to collect data shown in Table II. The interventions proposed in their study included manual assistive devices, mechanical devices and administrative management. When they applied ten interventions to ten tasks, the results showed that the biomechanical and EMG data in all interventions were statistically different between the intervention and non-intervention groups in joint moments, forces and muscle activity[11]. However, three out of ten interventions cannot prevent all risk of WMSDs including, i.e., bathing patient in bed (under side), making an occupied bed and dressing a patient in bed. Therefore, future research should investigate the tasks of nurses that are the risk factors of developing WMSDs and develop innovative ergonomic workstation designs to effectively prevent WMSDs in nurses.

Weiner *et al.*[12] studied about repositioning a passive patient upwards in bed by choosing an assistive device including regular cotton sheet, sliding sheet and carrier and predicted the risk for low back disorder based on the LMM torso kinematic inputs. The result showed that assistive devices used by nursing personnel had a significant influence on the back, upper limbs, shoulders and neck loading, and the result from the focus group indicated that nurses were satisfied to use the sliding sheet because it can be kept under the patient for extended periods, while using a carrier required extracting it out after every repositioning of the patient.

From the above discussion, it can be seen that many guidelines and new ergonomic workstations were designed according to the position of work and job characteristics. When they compared the EMG activities between before and after intervention, EMG activities in after intervention were found less than before intervention. However, if the intervention by workstation redesign has some limitations, the guidelines or administrative controls will be used.

Conclusion

The most common interventions used in HCWs were introducing arm support and height adjustments. WMSDs among HCWs were found to vary based on the position of work and job characteristics. Therefore, in future research, workstation redesign should also be considered according to the position of work and job characteristics of HCWs. This literature review offers evidence that the ergonomically designed workstation is the recommended intervention that can reduce and prevent the risk factors of WMSDs among HCWs in terms of muscle activity, force and job satisfaction. This study provides directions for future research on developing ergonomic intervention or innovation to prevent the risk factors of WMSDs among HCWs.

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