ORIGINAL ARTICLE

POTENTIAL OF PARTICIPATORY ERGONOMIC INTERVENTION APPROACHES TO REDUCE WORK-RELATED MUSCULOSKELETAL DISORDERS AMONG OFFICE WORKERS: A REVIEW

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ABSTRACT

Musculoskeletal disorders (MSDs) are a prevalent issue affecting office workers worldwide and resulting in economic losses and health problems. Pursuing of suitable ergonomic interventions approaches became an inescapable need in order of overcoming the future forecast that expects increased proportion of office-based worker as result of rapid growth of information technology. Participatory ergonomic intervention approaches emerge as a promising ergonomic intervention method to lower the work-related musculoskeletal disorders among office workers. This review underlines the ergonomic intervention methods that have been tried or tested for work-related musculoskeletal disorders reduction in office settings. The current status of using participatory ergonomic intervention approaches has shown potential effectiveness in reducing the prevalence of work-related MSDs. The future perspectives (strengths and opportunities) of these participatory ergonomic intervention approaches includes cost effectiveness, needed materials are simple and effortlessly acquired, and of low-cost. But then, the knowledge gaps (threats and weaknesses) regarding these participatory approaches comprise the lack of quality evaluation studies. Using participatory ergonomic intervention approaches is an imperative component that might help in reducing the prevalence of WMSDs among office-workers in both developed and developing countries and being reliable methods than other sophisticated or high-cost ergonomic intervention methods.

Keywords: *participatory intervention, ergonomic, office-workers, musculoskeletal disorders*

INTRODUCTION

The term musculoskeletal disorders (MSDs) denotes health problems of the locomotor apparatus, i.e. of muscles, tendons, the skeleton, cartilage, ligaments, and nerves (Alwin Luttmann et al., 2003). Musculoskeletal disorders (MSDs) include a wide range of inflammatory and degenerative conditions that affect the muscles, tendons, ligaments, joints, peripheral nerves, and supporting blood vessels leading to possible eventual resultants of soreness and lack of physical comfort (Punnett & Wegman, 2004; Summers & Bevan, 2015). According to Bone and Joint Initiative - USA (2015), musculoskeletal disorders found to influence more than 1.7 billion individuals around the world among the global burden of disease and the worldwide impact of all diseases, and ranked second most prominent cause of disability with the fourth most noteworthy effect on overall health of the world population while considering death and disability.

Defined as musculoskeletal disorders that results from a work-related event (Salik & Ozcan, 2004); work-related musculoskeletal disorders (WMSDs) are the major causes of occupational injury resulting in disability that leading to incompetence, loss of productivity and economic burden in developed as well as developing countries (Genaidy, Al-Shedi, & Shell, 1993; Kim et al., 2010). Factors that have been associated with WMSDs prevalence including; highly or repetitive motion/work, forceful exertion, excessive mechanical force, awkward postures, vibration and extreme environment (Lei, Dempsey, Xu, Ge, & Liang, 2005; Niu, 2010; Punnett & Wegman, 2004).

WMSDs are widespread globally resulting in considerable taken a toll as far as lost workdays, compensation and insurance expenses, as well as effects on human wellbeing (R. A. Aziz, Rani, Rohani, Adeyemi, & Omar, 2013; Piedrahita,

2006; M. M. Robertson & O'Neill, 2003). Bevan (2015) reported that WMSDs are accounted for 50% of all absences from work lasting for more than three days and almost 60% of all reported cases of permanent incapacity. Not only that, according to that same analysis; WMSDs were responsible for 40-50% of the costs of all work-related health issues in Europe. Furthermore, WMSDs account for 29% of all work-related injuries in the USA, and representing the high cost for medical expenses (Chorus, Miedema, Boonen, & Van Der Linden, 2003; Summers & Bevan, 2015). On the other hand, it has conclusively been shown that WMSDs and their related expenses represent huge issues in developing countries with considerable effect on both productivity and workplace environment (Ekpenyong & Inyang, 2014; Mbada et al., 2012; Piedrahita, 2006). It worth mentioning that, the economic losses suffered as a result of such disorders affect not only individuals but organizations and the society as a whole (Abareshi, Yarahmadi, Solhi, & Farshad, 2015).

Office based work considered to be the sedentary occupation and has been connected with high rates of MSDs prevalence (Leyshon et al., 2010; M. Robertson et al., 2009). Not surprisingly, biomechanical work requirements related to office based work incorporate extended sitting time in settled and possibly awkward postures, with repetitive movements and robust efforts have been related to symptoms of MSDs (Genaidy et al., 1993; Gerr et al., 2002; Janwantanakul, Pensri, Jiamjarasrangsri, & Sinsongsook, 2008). Moreover, several studies investigating prevalence rates of MSDs among office workers have been carried out and showed that MSDs have prompted to decrease of productivity, and turned into a high budgetary burden on economic and health systems (Choobineh, Daneshmandi, Kazem, & Zadeh, 2016; Harcombe, Mcbride, Derrett, & Gray, 2009; Linaker, Harris, Cooper, Coggon, & Palmer, 2011; Loghmani, Golshiri, Zamani, & Kheirmand, 2013).

In the past few years, the office ergonomics has attracted much attention due to the increment of office based workers as a result of the rapid growth of information technologies (Chandra, Chandna, Deswal, & Kumar, 2009). According to Brounen and Eichholtz (2004) and Veitch et al. (2007), it is estimated that at least 50% of the world's population currently works in some form of office. Furthermore, the proportion of office workers is expected to further increase (Gavriel Salvendy, 2012). However, it is reported that yet still there are a significant number of office workers suffering musculoskeletal disorders (MSDs) or some work-related problems (Balakrishnan, Chellappan, & Changalai, 2016; Choobineh et al., 2016; Janwantanakul et al., 2008; Lei et al., 2005).

It has conclusively been shown that ergonomic intervention is essential and inevitable to reduce accelerating MSDs prevalence. This is to get rid of the increasing costs related to medical, compensation, lack of working ability and decrease of productivity as well as undesirable effects on human well-being (Leyshon et al., 2010; Rudakewych, Valent-Weitz, & Hedge, 2001; Vilsteren et al., 2015). Therefore, ergonomic interventions as individual training and behavioural mediations (workstation changes) may give answers for these issues (Norashikin Mahmud, Kenny, & Rahman, 2012). In spite of the studies revealing that ergonomic adjustments are essentially efficient for mitigating work related musculoskeletal disorders (Abareshi et al., 2015; Choobineh, Motamedzade, Kazemi, Moghimbeigi, & Heidari Pahlavian, 2011; Hoe, Urquhart, Kelsall, & Sim, 2012; Norashikin Mahmud et al., 2012; Norashikin Mahmud, Kenny, Zein, & Hassan, 2011); yet, there is little or no agreement on the most proper

intervention for reducing MSDs (D. Van Eerd et al., 2015). Moreover, alongside the wide assortment of ergonomic interventions, there is additionally a wide range of study designs and techniques utilized by ergonomic specialists making it troublesome for discoveries among concentrates to be thought about and deciphered (Leyshon et al., 2010). Despite the fact that study researches and reviews have demonstrated an advantageous impact for ergonomic adjustment and exercise, compliance particularly over time is a matter of concern (Westgaard, 2000). However, interestingly, some studies were not able to demonstrate a significant impact of ergonomic intervention or exercises (Maher, 2001). In addition and in spite of the fact that some studies have shown that ergonomic interventions are significantly efficient to relief MSDs; yet still posing considerable costs, which is a vital economic issue. Subsequently, considering low-cost ergonomic intervention techniques is more practical to facilitate ergonomics improvements especially in developing countries (Gangopadhyay & Dev, 2014; K. Kogi, 2012; Kazutaka Kogi, Kawakami, Itani, & Batino, 2003; Mehrparvar et al., 2014).

The performance of some ergonomic intervention approaches that have been tested by earlier studies for reducing MSDs and its associated risk factors among office workers have been reviewed in this paper. Table 1 illustrates the summary of some ergonomic intervention approaches held to reduce work-related MSDs prevalence among office-workers in different countries.

Table 1 Summary of some ergonomic intervention approaches tested to reduce work-related MSDs prevalence among office-workers

Author and date	Country	Title	Study design	Intervention	Study population/ (n)	Significant Findings
(Norashikin Mahmud et al., 2012)	Malaysia	The Effect of Workplace Office Ergonomics Intervention on Reducing Neck and Shoulder Complaints and Sickness Absence	Cluster randomized controlled trial	Ergonomics Training	Office workers (179)	Reducing neck complaints among workers
(Baydur, Ergor, Demiral, & Akalin, 2016)	Turkey	Effects of participatory ergonomic intervention on the development of upper extremity musculoskeletal disorders and disability in office employees using a computer	Randomized controlled intervention	Training on risk identification	Office workers using computers (116)	Decrease developing MSDs symptoms
(Mehrparvar et al., 2014)	Iran	Ergonomic intervention, workplace exercises and musculoskeletal complaints: a comparative study	Intervention study	A)Ergonomic modifications for workstation and equipment B)Training to exercise regularly	Office workers (181)	Short-term effect on reducing MSDs pain

Table 1 (Continued)

Author and date	Country	Title	Study design	Intervention	Study population/ (n)	Significant Findings
(N. Mahmud, Kenny, Md. Zein, & Hassan, 2011)	Malaysia	The Effects of Office Ergonomic Training on Musculoskeletal Complaints, Sickness Absence, and Psychological Well-Being: A Cluster Randomized Control Trial	Cluster randomized controlled trial	Office ergonomics training	Office workers (92)	-Reductions in neck & upper and lower back complaints -Reduction in workers' stress
(Norashikin Mahmud et al., 2011)	Malaysia	Ergonomic training reduces musculoskeletal disorders among office workers: results from the 6-month follow-up	Cluster randomized controlled trial	Office ergonomic training	Office workers (128)	Improvement of workstation habits and reduced MSDs
(M. Robertson et al., 2009)	USA	The effects of an office ergonomics training and chair intervention on worker knowledge, behavior and musculoskeletal risk	A quasi-experimental	A)Ergonomic training B)Ergonomic training and adjustable chair	Office workers (219)	- Increase in overall ergonomic knowledge -Lower musculoskeletal risk
(M. M. Robertson & O'Neill, 2003)	USA	Reducing musculoskeletal discomfort: effects of an office ergonomics workplace and training intervention.	A quasi-experimental	A)Office Ergonomics Training B)Flexible space and adjustable workstations	Office workers (679)	- Increase in office ergonomics knowledge - Reduction in work related discomfort
(DeRango et al., 2003)	USA	The Productivity Consequences of Two Ergonomic Interventions	A quasi-experimental	A)Ergonomic chair and ergonomic training B)Office ergonomics training	Office workers (200)	The chair-with-training intervention reduced pain and improved productivity.
(Rudakewych et al., 2001)	USA	Effects of an Ergonomic Intervention on Musculoskeletal Discomfort among Office Workers	A quasi-experimental	Work station modification (keyboard, mouse tray, ergonomic chair), and ergonomics training.	Office workers (356)	Reduced the prevalence of musculoskeletal symptoms by 40%
(Voerman et al., 2007)	Sweden and Netherlands	Effects of ambulant myofeedback training and ergonomic counselling in female computer workers with work-related neck-shoulder complaints: A Randomized controlled trial	Randomized controlled trial	Ambulant myofeedback training combined with ergonomic counselling	Female computer workers (79)	Reduced MSDs pain intensity and disability

Table 1 (Continued)

Author and date	Country	Title	Study design	Intervention	Study population/ (n)	Significant Findings
(Martin, Irvine, Fluharty, & Gatty, 2003)	USA	A comprehensive work injury prevention program with clerical and office workers: phase I.	Randomized controlled trial	Training program: multi-faceted injury prevention program	Female clerical/office-workers (16)	Decrease in Lower Back ache/pain from
(Martin et al., 2003)	USA	A comprehensive work injury prevention program with clerical and office workers: phase I.	Randomized controlled trial	Training program: multi-faceted injury prevention program	Female clerical/office-workers (16)	Decrease in Lower Back ache/pain from
(King et al., 2013)	Canada	A pilot randomized control trial of the effectiveness of a biofeedback mouse in reducing self-reported pain among office workers	longitudinal pilot RCT	Hoverstop1 mouse (Vibramouse 2011)	Office workers (23)	Reduction in shoulder pain and discomfort
(Blangsted, Søggaard, Hansen, Hannerz, & Sjøgaard, 2008)	Denmark	One-year randomized controlled trial with different physical-activity programs to reduce musculoskeletal symptoms in the neck and shoulders among office workers	Randomized controlled trial	A)Specific resistance training (SRT) of the neck-shoulder region B)All-round physical exercise (APE)	Office workers (549)	Lower prevalence of neck-shoulder symptoms
(Sjogren et al., 2005)	Finland	Effects of a workplace physical exercise intervention on the intensity of headache and neck and shoulder symptoms and upper extremity muscular strength of office workers: A cluster randomized controlled cross-over trial	Cluster randomized cross-over design	Physical exercise intervention	Office workers (53)	No effect on the intensity of shoulder symptoms or the flexion strength of the upper extremities
(Choobineh et al., 2011)	Iran	The impact of ergonomics intervention on psychosocial factors and musculoskeletal symptoms among office workers	A quasi-experimental	Educational intervention (ergonomics training)	Office workers (134)	Symptoms in upper back, lower back and feet/ankles regions reduced
(Joshi & Bellad, 2011)	India	Effect of yogic exercises on symptoms of musculoskeletal disorders of upper limbs among computer users: a randomized controlled trial.	Randomized controlled trial	Yogic exercise with counselling	Office workers (60)	Relieved computer-related musculoskeletal disorders.

Table 1 (Continued)

Author and date	Country	Title	Study design	Intervention	Study population/ (n)	Significant Findings
(Tsauo, Lee, Hsu, Chen, & Chen, 2004)	Taiwan	Physical exercise and health education for neck and shoulder complaints among sedentary workers	Comparative study design	Intensive team-exercise program	Office workers (178)	Reducing neck and shoulder symptoms

In light of the ebb and flow challenges with respect to high prevalence of work related MSDs among office workers (Mbada *et al.*, 2012; Kunda, Frantz and Karachi, 2013; Mozafari *et al.*, 2014; Maakip, Keegel and Oakman, 2015; Ba *et al.*, 2016; Balakrishnan, Chellappan and Changalai, 2016), and prognostic growing rates of incidence almost all over the globe due to expected increment in office worker numbers (Bohr, 2000; Mahmud, Bahari and Zainudin, 2014; Aziz *et al.*, 2015), there is necessity for more extensive reviews. Those reviews are to investigate the ergonomic interventions those can actively play a role in decreasing overwhelming MSDs prevalence rates among office workers and back if not substitute the current ergonomic interventions, bearing in mind the ultimate need of guaranteeing raise of awareness as well as using available local materials and technologies to be implemented to ensure reliability and sustainability of these ergonomic interventions. Such display, will in particular, serve as an aid for future exploration to guarantee the finding of sustainable and reliable ergonomic interventions. For that cause and hence limited to, the motive of this review of related studies is to highlight the current status of the ergonomic interventions that have been tested for reducing the prevalence of MSDs among office workers. In this review, strength, weakness, opportunities, and threat (SWOT) analysis was applied to give a comprehension of future viewpoints and the knowledge gaps in connection with low-cost participatory ergonomic interventions, particularly in developing countries. Finally, the last aim of this review is to provide state –of the knowledge about participatory ergonomic intervention methods that can be an effective tool for reducing the prevalence rates of MSDs among office workers in developing countries.

Participatory Ergonomic Intervention (PE)

Finding practical low-cost ergonomic answers for work related musculoskeletal disorders can extend from smaller scale issues (micro) those require singular plan for a solitary user work-station to the large scale issues (macro) taking a gander at frameworks for both strategically viewing and operational procedures. In this regard, Participatory Ergonomic (PE) interventions are viewed as valuable for lowering the work related musculoskeletal issue (Eerd *et al.*, 2008).

The meaning of participatory methodologies incorporates intervention at large scale (macro) eg. organizational and systems levels, and in addition small scale (micro) eg individual, where workers are given the chance and authority to utilize their knowledge to handle ergonomic issues related to work tasks they perform. (Hignett, Wilson and Morris, 2005)

Wilson and Haines (1997) defined participatory ergonomics as ‘’the involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both

processes and outcomes in order to achieve desirable goals''. Participatory techniques are progressively used in enhancing ergonomics of workplaces. The benefits of these techniques are generally perceived as methods for promoting initiatives of local individuals and accomplishing desired workplace solutions (Kogi, 2006).

Recently, participatory action-oriented methods have gained an increasing attention globally in improving ergonomics and preventing work related injuries. Moreover, these participatory approaches were undertaken often to reduce onsite risks as in the case of work-places experience, work-related accidents, and illnesses such as musculoskeletal disorders (Kogi *et al.*, 2003). Among them, participatory action-oriented training (PAOT) is a practical method of supporting workplace initiatives based on self-help voluntary actions (Khai, Kawakami and Kogi, 2011; Nguyen and Khai, 2014). As a participatory approach, PAOT set to improve the work-place conditions or working environment, dealing with problems linked to work strain, and WMSDs or low productivity (Kogi, 2012). PAOT is backed by the International Labour Organization (ILO), and accepted to be one of the most functional methods for enhancing health and safety at work. PAOT is an occupational health training program that uses a widely-applicable participatory approach involving employees and employers in making their work environment safer, more productive, and less harmful to their health (ILO, 2010). Furthermore, utilizing unique training tools is a remarkable feature of PAOT, these tools including checklist exercises, low-cost improvements, and constant follow up visits and meeting events to discuss progress and achievements obtained (Khai, Kawakami and Kogi, 2011).

Future Perspective and Current Knowledge Gaps

A SWOT analysis has been applied to highlight the future perspectives (strengths and opportunities) and current knowledge gaps (threats and weaknesses) of utilizing of participatory ergonomic intervention approaches to reduce work-related MSDs (Table 2). Opportunities and threats are elements of the outside settings (external factors), while strengths and weakness are elements of the system (internal issues). In particular, SWOT analysis helps to find the best match between environmental trends (opportunities and threats) and internal capabilities (strengths and weakness). In the utilization of SWOT examination, weakness and threats ought to be minimized and kept away from. Weakness ought to be enhanced into strength, while threats ought to be changed over into opportunities (Pickton & Wright, 1998).

Participatory ergonomic interventions are by all accounts solid and powerful effective ergonomic intervention techniques for reducing work-related MSDs because of its strength. A portion of the strengths of the low-cost materials to be utilized as a part of the ergonomic intervention in light of the SWOT analysis incorporate cost effectiveness, effortlessly acquired simple materials, and financially affordable. These strengths are critical keys for utilizing these approaches as a reliable option for ergonomic intervention since they are using local easy accessible materials, economical and feasible options than other complicated or high-cost ergonomic intervention approaches. In another aspect, their ability to allow immediate improvements in occupational safety and health and working conditions is a clear advantage which encourages the use of these approaches especially in developing countries (Kawakami, Kogi, Toyama, & Yoshikawa, 2004; K Kogi, 2007; Kazutaka Kogi, 2006a). Nonetheless, in addition

to the possibility of these low-cost ergonomic intervention to be implemented at all kinds of workplaces including small workplaces (Kazutaka Kogi, 2006a), also it is effective, simple and economical for using in both the developed and developing countries (Hignett et al., 2005; K Kogi, 2002; Scott, Kogi, & McPhee, 2010).

However, while it is clearly shown from a review by Kogi (2012) that participatory ergonomic interventions are useful in supporting the initiatives of local people to make improvements and the application of realistic solutions in their workplaces; it is specifically noteworthy that the participants of the intervention approaches ought to be guided to talk about the good points of existing working environment conditions and after that to examine the needful improvement action.

Moreover, the opportunities for participatory ergonomic interventions approaches include potential better strategies and procedures regarding promote of risk-modifying behaviors. Yet, these opportunities need to be further investigated and studied (Jung, 2014; Nguyen & Khai, 2014). Furthermore, the concept of flexibility of ergonomic training that can be tailored to the specifics of the desired workplace risks/hazards to achieve pre-set goals (Rivilis et al., 2008), make it easy for the participating workers and managers to plan immediate actions in multiple technical areas (Kazutaka Kogi, 2008)

The current knowledge gaps (threats and weakness) relating to the participatory ergonomic interventions approaches have been shown using SWOT analysis. Participatory ergonomic interventions methods face a lack of effectiveness in terms of lack of quality evaluation studies (Hignett et al., 2005). A knowledge gap is seen in terms of the requirement to form an appropriate participatory ergonomic team to guide the intervention process (V. Eerd et al., 2008), yet this team composition and responsibilities need more studies and evaluation. Moreover, the possibility of prolonged time that may be needed to execute needed changes to arrive at better working conditions, is another issue that needs to be addressed to assure the sustainability and efficiency of participatory ergonomic interventions approaches (Karwowski & Marras, 1999; Vink et al., 1995).

Tables 2 Summary of SWOT analysis for participatory ergonomic intervention approaches used to reduce work-related musculoskeletal disorders

Future perspectives	
Strengths	Opportunities
• Simple and low-cost improvements in improving multiple aspects of existing workplace conditions (Kazutaka Kogi, 2006a; Kazutaka Kogi et al., 2003)	• Usefulness in supporting the initiative of local people to make improvements and the application of realistic solutions (K. Kogi, 2012)
• Effective and economical ergonomic approach to be used in both developed and developing countries (Hignett et al., 2005; K Kogi, 2002; Scott et al., 2010)	• Can promote risk-modifying behaviors (Jung, 2014; Nguyen & Khai, 2014)
• Practical wide application training tool to identify good points at any workplace (Khai & Kogi, 2011)	• Locally achievable makes it easy for the participating workers and managers to plan immediate actions in multiple technical areas (Kazutaka Kogi, 2008)
• Effective in reducing burden of work-related MSDs (V. Eerd et al., 2008; ILO, 2013)	
• Allow immediate improvements in occupational safety and health and working conditions (Kawakami et al., 2004; K Kogi, 2007)	• Ergonomic training needed is flexible and can be tailored to the specifics of the workplace risks/hazards or the targeted solutions (Rivilis et al., 2008)
• Recognized in all kinds of workplaces including small workplaces (Kazutaka Kogi, 2006a)	
Knowledge gaps	
Threats	Weakness
• Lack of quality evaluation (Hignett et al., 2005)	• Take relatively long time to arrive at better working conditions (Karwowski & Marras, 1999; Vink et al., 1995)
• Need of forming an appropriate participatory ergonomic team and information to be provided (V. Eerd et al., 2008)	

CONCLUSION

Work-related musculoskeletal disorders are the most prevalent lost-time injuries and illnesses in almost every industry around the world especially among office workers because of sedentary nature combined with office work. The inevitable ergonomic intervention methods to reduce accelerating MSDs prevalence, generally found to be ranging from effective to insignificant in eliminating work-related MSDs among office workers with no agreement on the most proper intervention approach.

Participatory ergonomic interventions are viewed as valuable for lowering the work-related MSDs among office workers. The SWOT analysis output showed the future perspectives (strengths and opportunities) and current knowledge gaps (threats and weaknesses) of participatory ergonomic intervention approaches. Cost effectiveness, using locally available materials and suitability of being used in all kinds of workplaces in addition to immediate improvements in occupational safety and health and working conditions, and being

effective ergonomic approach to reduce burden the of work-related MSDs in both developed and developing countries are the solid strengths of these participatory ergonomic intervention approaches. Furthermore, according to the SWOT analysis, the knowledge gaps (threats and weakness) connecting to participatory ergonomic intervention can be handled by more studies and evaluation of possibilities of enhancing the ergonomics awareness among workers. Using participatory ergonomic intervention approaches is an important factor that may lead to the reduction of work-related MSDs among office workers in developing countries. Finally, these participatory ergonomic intervention approaches are reliable option for MSDs reduction since they are more simple, economical and technologically feasible option than other complicated or high-cost ergonomic intervention approaches.

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