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NOTES

An Investigation of Ergonomics Analysis Tools Used in Industry in the Identification of Work-Related Musculoskeletal Disorders

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Web-based surveys were sent to Canadian certified ergonomists, Joint Health and Safety Committees (JHSCs) and health and safety certification trainers to understand better which ergonomics analysis tools were used in industry and help JHSCs obtain the necessary training required to reduce work-related musculoskeletal disorders (WMSDs). The results showed that most of the certified ergonomists used the Snook/Mital tables, the National Institute of Occupational Safety and Health (NIOSH) equation and rapid upper limb assessment (RULA)/rapid entire body assessment (REBA). The most frequently used methods by JHSCs to identify ergonomics risk were injury reports and worker complaints. The surveys for the health and safety certification trainers revealed that most curricula did not include ergonomics analysis tools. There appears to be a gap between what is recommended by certified ergonomists for JHSC, what is taught in training and what is used by JHSCs for ergonomics risk analysis. A better understanding, modifications in training curricula and education of JHSCs are needed to help reduce WMSDs.

ergonomics analysis tools surveys, certified ergonomists joint health and safety committees

1. INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) are a major concern in industry which can also compromise competitiveness due to costs related to worker compensation, labour turnover, absenteeism, poor quality and reduced productivity [1]. The ramifications of WMSDs are large in terms of both health and costs. In Ontario, Canada, the injury compensation costs in 2001 were approximately CAN $2.5 billion [2]. In 2003, there were over 40 000 reported WMSDs [3]. This represents over 40% of all workplace lost-time injuries. To reduce WMSDs the Ontario government has set up an ergonomics advisory group to recommend ways to protect workers.

Various ergonomics analysis tools are available for assessing exposure to risks associated with WMSDs. Analyses can be qualitative, semiquantitative or quantitative [4]. Qualitative analysis tools gather basic observational data about a job. These analysis tools generally require the least amount of effort from the analyst. Job analysis checklists are an example. Simple ergonomics analyses assess whether a risk factor is present. Semiquantitative analysis tools include

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both judgment data and simple quantitative data, e.g., Snook tables [5], the American Conference of Governmental Industrial Hygienists (ACGIH) hand activity level (HAL) threshold limit value (TLV) [6, 7] and the Washington Industrial Safety and Health Act (WISHA) hand–arm vibration analysis [8]. These analysis tools require more effort from the analyst as well as knowledge of ergonomics. Quantitative analysis tools include the National Institute of Occupational Safety and Health (NIOSH) lifting equation [9], the Moore-Garg strain index [10] and biomechanical analyses. These analysis tools require greater expertise by the analysts to perform more demanding quantitative computations. Complex analyses attempt to measure or predict the forces acting on or within the body. Which tool is used depends on the problem being investigated and the preference of the analyst. Dempsey, McGorry and Maynard [11] conducted a survey of ergonomics analysis tools and methods used by certified professional ergonomists in the USA. They found that manual material handling tools were the most used. Among the most popular were the NIOSH lifting equation and biomechanical models.

Unfortunately, despite the abundance of ergonomics analysis tools available, WMSDs continue to exist. Not every workplace has a qualified ergonomist with the necessary background to use the analysis tools properly and effectively. Ergonomics analysis tools can be difficult to use and require a real understanding of their limitations and underlying assumptions. These limitations and restrictions have been documented in the literature [12, 13, 14, 15]. Some movements can be hard to define (e.g., twisting); the same is true for postures of small joints such as the wrist and elbow [12]. It has also been suggested that the most appropriate assessment tool depends on the characteristics of the job [15]. This makes it even more difficult for those with limited ergonomics knowledge to use the tools correctly.

Under the Occupational Health and Safety Act [16], all workplaces are required to have Joint Health and Safety Representatives (JHSRs) or Joint Health and Safety Committees (JHSCs) depending on the company size. These JHSRs and JHSCs consist of both workers and management. In the absence of a qualified ergonomist, these individuals tend to be responsible for all of the ergonomic issues in the workplace. JHSR and JHSC members generally have a limited ergonomics background and would most likely not be able to use many of the existing ergonomics analysis tools correctly. There also tends to be time constraints since these individuals have other primary jobs to attend to in the workplace. Consequently, most workplaces tend to employ reactive ergonomics after injuries have already occurred as opposed to being proactive and preventing the injuries. To assist JHSRs and JHSCs, simplified, effective analysis tools are needed that provide clear information as to the potential risk to various body parts for different jobs/industries.

The overall purpose of this project was to obtain a better understanding of the ergonomics analysis tools used in industry to help JHSCs obtain the necessary training and tools required to reduce WMSDs in their organizations. The specific objectives of this research were to investigate which ergonomics tools were used most often in industry and how easy they were to use, investigate the ergonomics risk assessment methods used by JHSCs, and examine the ergonomics content in the curriculum taught to JHSCs.

2. METHODS

Web-based surveys were developed to investigate the ergonomic tools used by practicing certified ergonomists and JHSC members for the identification of ergonomics risk in the workplace. A survey for health and safety certification trainers was also developed to investigate which ergonomics tools were being taught as part of JHSC certification training. A list of certified ergonomists was created from the website of the Association of Canadian Ergonomists. A contact list for JHSC members was developed using labour union websites. For the health and safety trainers, all of the health and safety associations in Ontario were contacted. A contact e-mail was sent out to the three groups with information on the study and instructions on how to take part in the survey. Each group was provided with a

different username and password. Consent to participate was provided by participants that submitted a survey. This study was reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo.

2.1. Canadian Certified Ergonomists

The survey for the Canadian certified ergonomists consisted of two questions and a comments section. The first question asked the ergonomists to list the top five ergonomics analysis tools that they used on a regular basis and to rate their ease of use. The second question asked them which tools they would recommend for JHSC members with limited ergonomics knowledge.

2.2. Joint Health and Safety Committee Members

The JHSC member survey contained two questions and a comments section. The first question asked the members how they identified ergonomics risk in their organization. The second question asked them to list any ergonomics analysis tool that they used to evaluate ergonomics risk.

2.3. Health and Safety Certification Trainers

The survey for the health and safety certification trainers consisted of three questions and a comments section. The trainers were first asked if their curriculum included methods for ergonomics risk analysis. If they answered yes, they were asked to list the ergonomics analysis tools that they taught. They were also asked how much time was spent on ergonomics risk analysis tools.

3. RESULTS

3.1. Certified Ergonomists

A total of 18 certified ergonomists submitted the survey. Out of these, 17 completed the survey and one only filled out the comments section. Figure 1 shows the results of the most

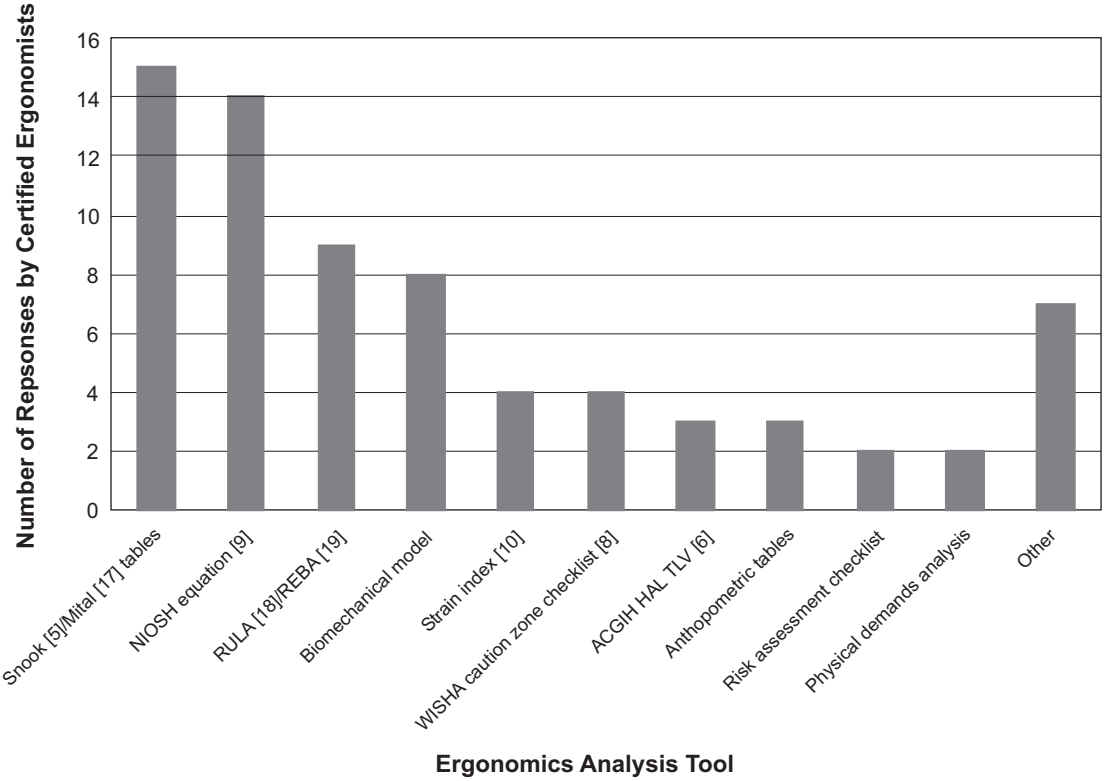

Figure 1. The ergonomics analysis tools most frequently used by the certified ergonomists surveyed. *Notes.* NIOSH—National Institute of Occupational Safety and Health, RULA—rapid upper limb assessment, REBA—rapid entire body assessment, WISHA—Washington Industrial Safety and Health Act, ACGIH—American Conference of Governmental Industrial Hygienists, HAL—hand activity level, TLV—threshold limit value.

frequently used ergonomics analysis tools by the surveyed certified ergonomists. The most frequently used ergonomics analysis tools were the Snook [5]/Mital [17] tables. They were used by 88% of the ergonomists that completed the question. The NIOSH equation [9] was used by 82% of the ergonomists and the rapid upper limb assessment (RULA) [18]/rapid entire body assessment (REBA) [19] by 53%. The Other category consisted of ergonomics analysis tools that were mentioned by only one ergonomist: energy expenditure; office ergonomics checklist; Ovako working posture analysis system (OWAS) [20]; Auburn Engineers[1] tools; Kilbom repetition tables [21, 22]; posture, activity, tools and handling (PATH) [23]; Ministry of Labour office ergonomics guidelines [24]; Washington State lifting calculator [25]; checklist; Canadian Standards Association[2] standards; and Ohio Bureau of Workers' Compensation lifting guidelines [26].

Figure 2 shows the certified ergonomists' ratings of how easy it was to use the ergonomics analysis tools on a regular basis. The scale ranged from 1 to 5 with 1 representing an easy ergonomics analysis tool that anyone could use and 5 representing an ergonomics analysis tool that could only be used by expert ergonomists. The results show that the certified ergonomists surveyed felt that the biomechanical models, ACGIH HAL TLV [6] and anthropometric tables were the most difficult to use (4—*difficult, need an ergonomics background*). The WISHA caution zone checklist [8] and risk assessment

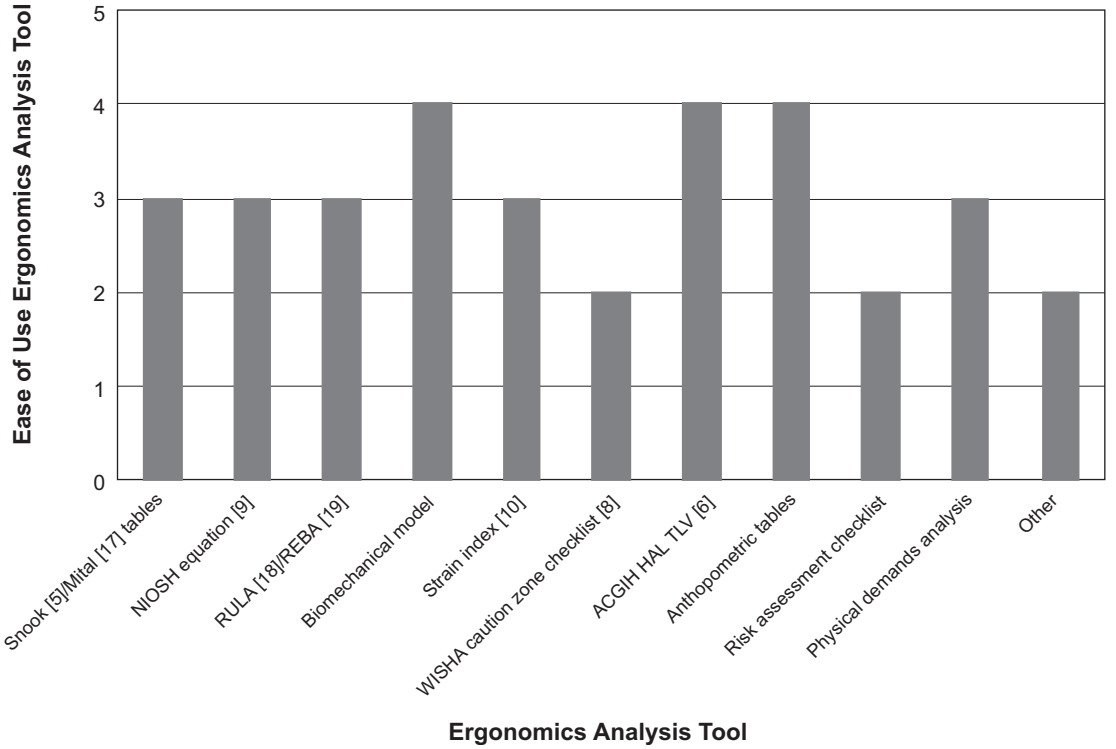

Figure 2. Ease-of-use ratings for the most frequently used ergonomics analysis tools by the certified ergonomists surveyed. *Notes.* **1***—easy, anyone can use it*; **2***—fairly easy, can be used by anyone with limited ergonomics knowledge*; **3***—intermediate, some ergonomics knowledge is required*; **4***—difficult, need an ergonomics background*; **5***—very difficult, for ergonomics experts.* NIOSH—National Institute of Occupational Safety and Health, RULA—rapid upper limb assessment, REBA—rapid entire body assessment, WISHA—Washington Industrial Safety and Health Act, ACGIH—American Conference of Governmental Industrial Hygienists, HAL—hand activity level, TLV—threshold limit value.

[1] http://www.ergopage.com/etools
[2] http://www.csa.ca

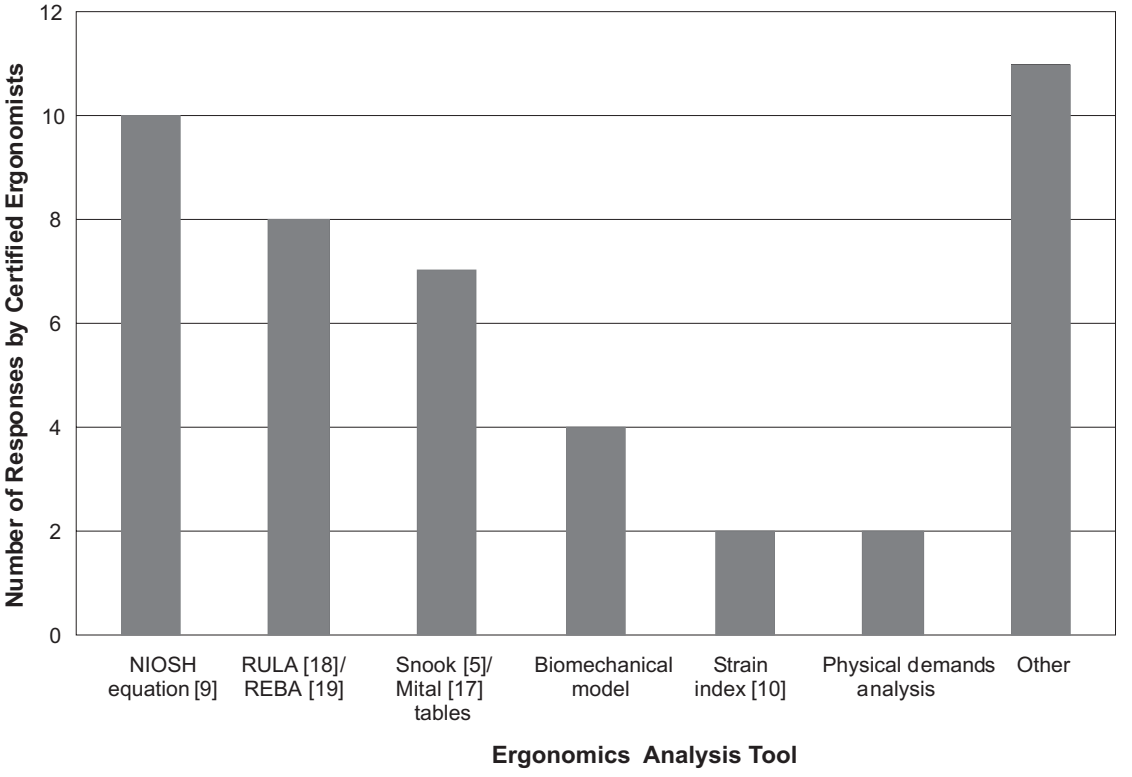

Figure 3. The ergonomics analysis tools recommended by the certified ergonomists surveyed for Joint Health and Safety Committee members with limited knowledge of ergonomics. *Notes.* NIOSH—National Institute of Occupational Safety and Health, RULA—rapid upper limb assessment, REBA—rapid entire body assessment.

checklists were rated 2 (*fairly easy, can be used by anyone with limited ergonomics knowledge*). The ergonomists felt that these were the easiest tools to use.

Figure 3 shows the ergonomics analysis tools that the certified ergonomists surveyed recommend for JHSC members. The NIOSH equation [9] was recommended by 59% of the ergonomists, RULA [18]/REBA [19] was recommended by 47% and the Snook [5]/Mital [17] tables by 24%.

In the comments section, the consensus was that there were very few ergonomics analysis tools available that required limited ergonomics knowledge. The certified ergonomists felt that training should always be provided since assessment tools with little knowledge could potentially do a lot of harm. It was also mentioned that there would always be limitations to what JHSCs could do and they should know when to ask for expert help.

3.2. Joint Health and Safety Committee Members

A total of 21 JHSC members submitted a survey. Figure 4 shows the ergonomics risk identification methods most frequently used by the participants. The results show that the most frequently used method of identifying ergonomics risk was injury reports with 71% of responses. Worker complaints/reports and ergonomics checklists/analysis were tied for second with 67% of responses. The Other category consisted of ergonomics risk identification methods that were recommended by only one JHSC member: occupational disease, pre-job start interview, employee safety forms, safety concerns resolution forms, union/management requests, time study requests, new equipment review, physical demands analysis, past experience, ergonomics improvement suggestion forms, and accident investigation.

Figure 5 shows the ergonomics analysis tools used by JHSC members in their workplace.

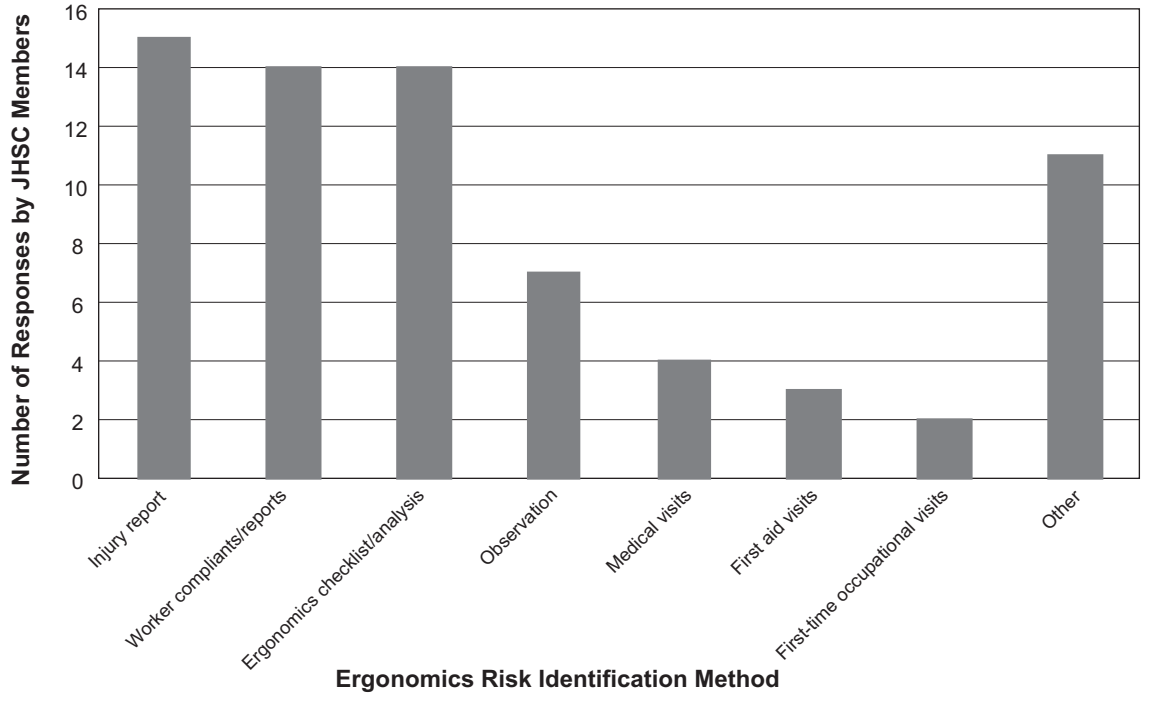

Figure 4. The ergonomics risk identification methods most frequently used by the Joint Health and Safety Committee (JHSC) members surveyed.

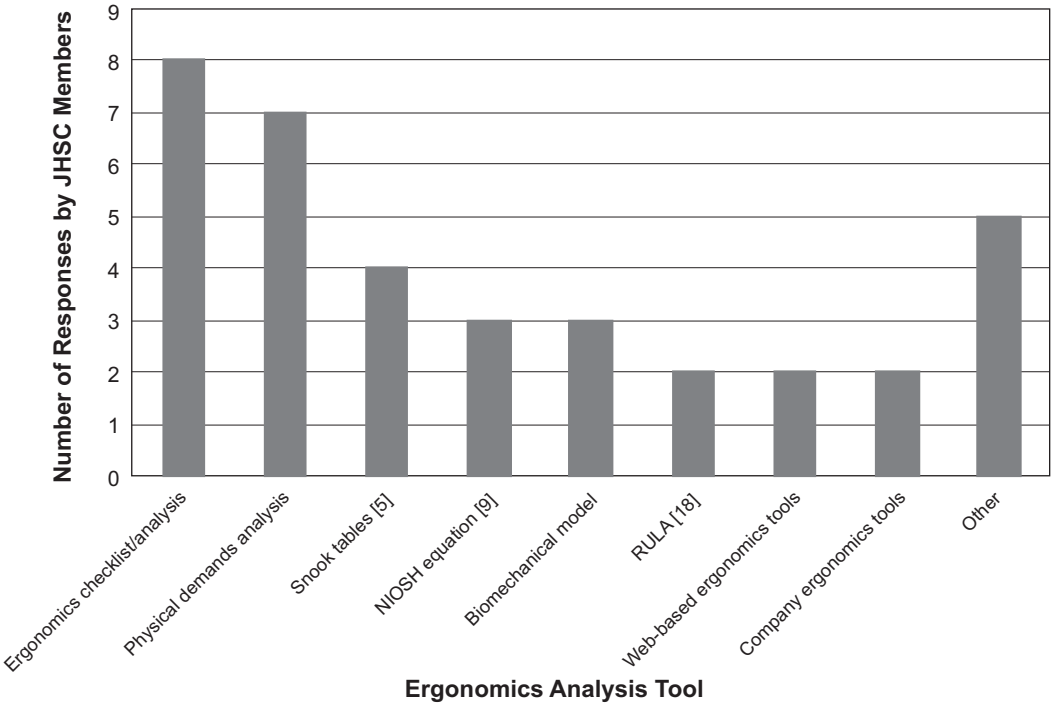

Figure 5. The ergonomics analysis tools most frequently used by the Joint Health and Safety Committee (JHSC) members surveyed. *Notes.* NIOSH—National Institute of Occupational Safety and Health, RULA—rapid upper limb assessment.

The most frequently mentioned ergonomics analysis tool was ergonomics checklists/analysis followed by physical demands analysis.

JHSC members commented that they needed more information to better assess ergonomics risk and develop solutions. They would have liked more ergonomics analysis tools such as job specific checklists and design guidelines. In some cases, the organizations had ergonomists that the JHSCs referred to for help but most of the JHSCs surveyed did not have ergonomists to ask for assistance. There was also a general agreement that management was not always supportive of an ergonomics program and provided very little help to the JHSC members in the reduction and identification of ergonomics risk.

3.3. Health and Safety Certification Trainers

Five health and safety certification trainers submitted a survey. Of these only two taught a curriculum that included ergonomics analysis tools for 1–3 hrs. In both cases, checklists were used. One of the trainers also taught physical demands analysis while the other one taught how to use the NIOSH equation [9] and the Snook tables [5] (Table 1).

TABLE 1. The Ergonomics Analysis Tools Taught by the Health and Safety Certification Trainers Surveyed

Ergonomics Analysis Tool	Responses
Checklists	2
Physical demands analysis	1
NIOSH equation [9]	1
Snook tables [5]	1

Notes. NIOSH—National Institute of Occupational Safety and Health.

A comment from one of the trainers was that in most cases ergonomics risk analysis was not taught in basic JHSC certification but in a separate program that companies could choose to send their employees to. According to another trainer more training was required regarding ergonomics risk assessment and solution development.

4. DISCUSSION

The information collected from the certified ergonomists shows that some ergonomics analysis tools are used more often than others are. Although the surveyed ergonomists provided recommendations on the ergonomic tools they thought would be useful for JHSC members to assess ergonomics risk, the top six ergonomics tools most frequently mentioned all required an intermediate knowledge of ergonomics. The results of the present study are similar to Dempsey et al.'s [11]. In their survey on observation techniques, the NIOSH equation [8], biomechanical models, RULA [18] and the strain index [10] were in the top six most used tools. It is important to note that their surveys provide the lists of ergonomic tools whereas in the present study the participants were asked to list the tools that they used the most.

The vast majority of ergonomics analysis tools require some knowledge of ergonomics and would not be appropriate for use by those with little or no training. The NIOSH equation [9], strain index [10] and biomechanical models are qualitative analysis tools that require greater ergonomic expertise. The Snook tables [5] and RULA [18]/REBA [19] are semiquantitative analysis tools that require some ergonomic knowledge. One of the simplest ergonomic tools is the checklist that can help to gather basic information about a job. Checklists require the least amount of effort by analysts. Better checklists that are more job specific will help JHSCs to better identify ergonomics risk. If JHSC members are unable to make accurate evaluations, they can look for help within or outside the organization if necessary. Training will always be a very important part of ergonomics assessments. Providing tools without proper training can lead to more harm than good. It is important that those conducting ergonomics evaluations should be competent and know when to ask for help.

The results from the JHSC surveys show that most ergonomics risk assessments are reactive and are performed mainly by looking at injury rates or worker complaints/reports. Some ergonomics analysis tools are used but the

comments from the participants indicate that they would like to have more training and better tools designed for specific jobs. The most frequently used tool was the checklist (71%). Dempsey et al. found the same [11]. Since most tools available are generic, it is more challenging to be able to use them correctly without a good understanding of the tools and a background in ergonomics. The lack of management support was quoted as a major obstacle in advancing ergonomics risk assessments and consequently decreasing WRMDs. Management support is the first step in the development of a successful ergonomics program [27].

The curriculum for JHSC members does not always include enough information on ergonomics risk assessment and ergonomics analysis tools are not always taught. Although in many organizations the JHSC is responsible for identifying and reducing ergonomics-related injuries, the results have shown that very few are receiving the proper training to be able to understand the problems associated with WRMDs and the proper tools to investigate and reduce these problems. With the high costs associated with lost-time injuries, it is clear that serious actions must be taken to reduce WMSDs. Since not all companies can afford a full-time ergonomist, providing JHSCs with the necessary training to assess ergonomics risk can help to identify problems and determine an action plan to eliminate them.

5. CONCLUSIONS AND RECOMMENDATIONS

The present work was a first attempt at determining the use of ergonomics analysis tools in industry. The results show that most ergonomics analysis tools available require some ergonomics knowledge. Unfortunately, most JHSC curricula have very limited ergonomics content; therefore JHSCs rely predominantly on injury reports and worker complains/reports to assess ergonomics risk. Better training and simpler tools, perhaps in the form of job/industry specific checklists, web-assisted online resources using the Snook tables [5], the NIOSH equation [9] and other tools identified in the survey, are needed to assist JHSCs in making baseline ergonomics risk assessments and to take a more proactive approach in the fight against WMSDs. People responsible for training JHSCs and for monitoring the performance of these committees must ensure that the key members in JHSCs have adequate training in ergonomics and that they are actually using some of the identified tools that require intermediate knowledge in their workplaces. Looking at the practicality of using some of these assessment methods by JHSCs in actual workplaces is one of the biggest challenges for future research in this area. It is clear from this research that there is a wide gap between what is recommended by certified ergonomists for JHSCs, what is taught in JHSC training classes and what is actually used or practiced by JHSCs. Hence, it is important to identify why the JHSCs are not using a number of these methods and what can be done to ensure they do.

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