# How does employer support and educational background effect an Ergonomics Practitioner's awareness of the relationship between ergonomics and psychosocial hazard control?

by

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A Thesis submitted to the

School of Graduate Studies

in partial fulfillment of the requirements for the degree of

**Master of Science (Kinesiology)**

School of Human Kinetics and Recreation

Memorial University of Newfoundland

May, 2016

St. John's, Newfoundland Labrador

## Abstract

There is a growning need to address psychological health and safety in the workplace. Ergonomics tends to be widely recognized for its physical applications, such as ¨office¨ and ¨manual materials handling¨ however the other domains of specialization of ergonomics (cognitive and organizational) appear to be less well known. This study evaluates the level of understanding that professionals who practice ergonomics have of the relation between ergonomics and the control of psychosocial hazards in the workplace. A survey was distributed to ergonomics practitioners and asked them about their awareness of the relation between ergonomics and workplace psychosocial hazard control. Ergonomists and human factors specialists demonstrated a greater awareness of this relationship than other allied occupational groups that also practice ergonomics, however they indicated that there may be difficulties in the "real world" applying these areas of knowledge into practice. Participants who demonstrated a high level of awareness of the relation between ergonomics and psychosocial hazard control demonstrated stronger organizational commitment than participants with a low awareness. Ergonomics practitioners who reported having employer support for professional development also demonstrated a higher degree of awareness of the relation between ergonomics and psychosocial hazard control, as did the professionals who had been practicing in the field the longest. This research provides some insight for professional associations for Ergonomists, employers of Ergonomists, and human resource professionals about how ergonomics practitioners perceive the ergonomics field and the profession as well as their employing organization.

## Acknowledgements

I would like to express my gratitude to my supervisor, Dr. Scott MacKinnon, without whose guidance and patience this would not have been completed. His useful comments and thought provoking feedback motivated deeper probing into this very interesting topic.

Thank you also to my supervisor Dr. Kate Dupré, who motivated me to think about how Occupational Health Psychology interacts with Ergonomics. Her teaching and discussions sparked my interest in the topic and lead me to want to know more.

Dr. Matthew Atkinson was integral to my understanding and appreciation of statistics. My "epiphany" about statistics would not have occurred without his clear and entertaining guidance.

I extend gratitude and appreciation for the people that participated in the survey. The survey targeted busy professionals whose time with the survey is greatly appreciated. Your insight and honesty helped to shape the work in this study.

Finally I would like to acknowledge those leading lights in Ergonomics all over the world; they have lead the way, and more will continue to do so now and in the future. You've taught us all, made us grow professionally and made us grow the profession. You have left (and will leave) a legacy in the field of Ergonomics.

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## Abbreviations and Definitions

| | |
|---|---|
| ACE: | Association of Canadian Ergonomists |
| AIHA: | American Industrial Hygienist Association |
| BCPE: | Board of Certified Professional Ergonomists |
| BCRSP: | Board of Certified Registered Safety Professionals |
| BLS: | Bureau of Labor Statistics |
| CAOT: | Canadian Association of Occupational Therapists |
| CCCPE: | Canadian College for the Certification of Professional Ergonomists |
| CHSC: | Certified Health and Safety Consultant |
| CKA: | Canadian Kinesiology Alliance |
| CPA: | Canadian Physiotherapy Association |
| CSA: | Canadian Standards Association |
| EP: | Ergonomics Practitioner |
| HF: | Human Factors |
| HFE: | Human Factors/Ergonomics |
| HFES: | Human Factors Ergonomics Society |
| HR: | Human Resources |
| IEA: | International Ergonomics Association |
| ILO: | International Labour Organization |
| MSI: | Musculoskeletal Injury |
| MSD: | Musculoskeletal Disorder |
| NIOSH: | National Institute of Occupational Safety and Health |
| OC: | Organizational Commitment |
| OHP: | Occupational Health Psychology |
| OHS: | Occupational Health and Safety |
| PC: | Professional Commitment |
| PE: | Participative Ergonomics |
| TCM: | Three Component Model |
| WHSCC: | Workplace Health, Safety and Compensation Commission |
| WHO: | World Health Organization |

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# CHAPTER 1: INTRODUCTION

## 1.1 The Field and Discipline of Ergonomics

"Ergonomics has, as its field, the human factor in practice, and its goal is the well-being of individuals, organizations and national economies" (Wilson, 2000). Very simply, ergonomics is a discipline concerned with fitting work, work environment and work systems to the needs, capabilities and limitations of humans. The term "ergonomics" was first coined in a philosophical narrative by Jastrzebowski in 1857 wherein he divided 'work' into two main categories; the useful work and the harmful (discreditable) work that brings deterioration (Karwowski, 1991).

The term "Ergonomics" later took its roots in Europe with an emphasis on physical ergonomics, whereas the term "Human Factors" evolved in North America with an emphasis on cognitive and organizational ergonomics. Some ergonomists and other groups define the terms "Ergonomics" and "Human Factors" differently. Other groups use the terms interchangeably. J.R. Wilson (2000) stated:

> We may regret that the term "ergonomics" lacks obvious meaning and impact for clients or the public, but genies can rarely be put back into bottles; it would now be a futile and damaging exercise to move away from use of the terms ergonomist and ergonomics. Ergonomists are what we are, ergonomics is both our discipline and our profession; our field of study is the theory and practice of understanding people and their characteristics (the human factors) in relation to design. (p. 559)

For the purposes of this study, the terms "ergonomics" and "Ergonomist" will be used unless quoted otherwise in referenced literature.

Optimizing human well-being and overall system performance requires consideration of physical, cognitive and organizational characteristics of workers, their tasks, jobs and the systems within which they work, even the systems within which the systems operate. These contributions affect one another and do not exist in isolation from one another in any work system (Fischer & Zink, 2012; Genaidy, Karwowski & Christensen, 1999; Kubek, Fischer & Zink, 2015). Utilizing only a narrow or singular application of ergonomics which does not take all of the above into consideration, "has a high probability of creating systems in which the personnel subsystem [of an organization] is forced to adapt to the system's technology and structure in a 'pounding a square peg into round holes' fashion" (Hendrick, 1991, p. 753).

### 1.1.1 What is an Ergonomist?

According to the Association of Canadian Ergonomists (ACE), "Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people. Ergonomists use a holistic approach and will ensure that physical, cognitive, social, organizational, environmental and other relevant factors are taken into account when making recommendations regarding the design or modification of a system" ("About Ergonomics", n.d.).

The field of ergonomics attracts professionals from a variety of academic and professional backgrounds and interests. As a result, the people that practice in the field have varied perspectives, and apply ergonomics in a number of settings (e.g. research, academia, policy planning, systems design, consulting, health and safety and product design). Some practitioners define themselves as Ergonomists, and some identify more with their primary academic and professional background, for example Industrial Engineer, Kinesiologist or Occupational Health and Safety Professional. Ergonomists practice ergonomics as their primary role in their professional positions while many other professionals practice ergonomics as a part of their overall work, but not necessarily as their primary role. For purposes of this study, all professions (including certified Ergonomists) will be described collectively as "ergonomics practitioners" (EP) unless required otherwise for clarity.

### 1.1.2 Musculoskeletal Injuries

EPs often differentiate between the terms "Musculoskeletal Injury" (MSI) and "Musculoskeletal Disorder" (MSD). For the purposes of this study, the term MSI will be used, except where quoted differently in referenced literature. MSIs are defined by the Canadian Standards Association (CSA) (2012) Standard Z1004-12, "Workplace Ergonomics – a management and implementation Standard" as being "injuries and disorders of the musculoskeletal system (the muscles, tendons, tendon sheaths, nerves, bursa, blood vessels, bones, joints/spinal discs, and ligaments) that can be caused or aggravated by various hazards or risk factors in the workplace" (p.6).

Over the past several decades a significant concern in the occupational health and safety field has been the high incidence of workplace MSIs. Accompanying the experience of workplace MSIs has been a growing financial and human resource cost to businesses and workers over the past decades. For example, in Ontario MSIs account for over 40 percent of all lost-time claims and 50 percent of all lost-time days registered with the Workplace Safety and Insurance Board (Occupational Health and Safety Council of Ontario (OHSCO), 2007). McGee, Bevan and Quadrello (2011) reported MSIs to be the number one cause of work-related lost-time claims in Canada, and to cost workplaces hundreds of millions of dollars from absenteeism and lost productivity.

The need to find ways to prevent workplace MSIs from occurring has been a major economic and productivity concern for businesses and insurance companies, who have turned to the use of ergonomics in the workplace to address MSI issues. Despite the breadth of the field of ergonomics (to include matters of cognition and organization), it became known by many as the field whose practitioners (qualified academically or not) were responsible for setting up physical office/computer workstations appropriately, or for training workers on safe lifting techniques, all with the intended goal of decreasing MSIs.

### 1.1.3 Psychosocial Hazards

Work related stress is the response people may have when presented with work demands and pressures that are not matched to their knowledge and abilities and which challenge their ability to cope (Leka, Griffiths & Cox, 2003). Experiencing interactions

with elements of work (job content, work organization & management and other environmental conditions) that exceed a person's competencies and do not meet their needs is considered to be a psychosocial hazard (International Labour Organisation [ILO], 1986).

Work related stress has, for some time now, been identified as being present amongst workers in the North American workforce (Dekker & Barling 1995; Jamal, 1997; Landsbergis, 1988; Landsbergis, Cahill and Schnall 1999; Levi, Sauter and Shimomitsu, 1999; Sauter, Hurell, Murphy & Levi, 1998;). It was identified as being increasingly apparent in the workplace as early as 1966 (Sauter et al., 1998). Technological change and the increasing psychological demands of the workplace were listed as being contributing factors. It is not a new phenomenon.

The terms "psychological" and "psychosocial" hazards might be used interchangeably in the literature. Similarly, the terms psychosocial "hazard", psychosocial "risk" or psychosocial "factor" are used. Based on the terminology adopted by the Canadian Standards Association (CSA) Standard Z1003, "Psychological health and safety in the workplace – Prevention, promotion, and guidance to staged implementation"(CSA, 2013) and for the purposes of this study, the term "psychosocial hazard" is used except where quoted differently in referenced literature.

### 1.1.4 How Ergonomics is perceived

This study seeks to demonstrate whether there is a lack of awareness amongst EPs, of the breadth of ergonomics, specifically with regard to psychosocial hazard control in the workplace, independent of the association with MSIs. Awareness of the relation between ergonomics and psychosocial hazard control in the workplace, independent of MSIs is referred to in this document as "awareness". Some EPs appear to define ergonomics narrowly, possibly only in relation to their own individual areas of practice. For example the American Industrial Hygiene Association (AIHA) states in their Position Statement on Ergonomics (AIHA, 2009) that ergonomics is "a multidisciplinary science whose primary focus is the anticipation, recognition, evaluation, and control of musculoskeletal disorders (MSD) and their risk factors in the workplace". The College of Kinesiologists of Ontario stipulates that Kinesiologists must be able to demonstrate "an understanding of ergonomics as it relates to human movement and performance" ("Essential Competencies of Practice for Kinesiologists in Ontario" (2014), p.12).

Dul et al., (2012a) note that "the very strength of [ergonomics], its multidisciplinary base, is also a potential weakness", "resulting in sending unclear messages" (p.2). This could contribute to a possible lack of "awareness" amongst EPs. Caple (2010) provided a review of the International Ergonomics Association's (IEA) contribution to the transition of ergonomics from research to practice. He concluded that "further research is required to define holistic models of ergonomics methodologies that embrace the diversity of ergonomics areas of research and application in order to assist external stakeholders to understand the core elements of the ergonomics domain" (p. 237).

The increased awareness of ergonomics by insurance companies, rehabilitation clinics and public policy makers among others as a means to prevent MSIs, may have had a significant impact on the image of ergonomics by recognizing it as a means to help control the immense costs of MSIs in North American workplaces. This perspective focuses on the "physical" domain of ergonomics only, leaving the broader (and more effective holistically) perspective of cognitive and organizational ergonomics out.

### 1.1.5 Professional and Organizational Commitment

Organizational Commitment (OC) and Professional Commitment (PC) are attitude constructs. OC is considered to be an individual's psychological attachment to the organization. For purposes of this paper, the "organization" is the employing organization of the EP. Porter, Steers, Mowday and Boulian (1974) define it as being the strength of an individual's identification with, and involvement in, the goals and values of a particular organization. Some factors such as empowerment, skill variety, job scope, leader communication and salary, have been shown to be connected to a worker's sense of OC (Benkhoff, 1997; Dick, 2011; Jha, 2011). Similarly, professional (or occupational) commitment (PC) is an individual's degree of psychological attachment to their profession. It is characterized by the sharing of beliefs, goals and values of the profession (Hall, Smith & Langfield-Smith, 2005; Lachman & Aranya, 1986; Lemmens, Strating, Huijsman & Nieboer, 2009).

OC and PC can be influenced in a number of ways, including employer support, level of autonomy in a work setting, job satisfaction, position in an organization, financial

remuneration, opportunities for advancement and other factors in an organization or a profession (Lee, Carswell & Allen, 2000; Giffords, 2003; Giffords, 2009; Veličković, 2014; Wallace, 1995). It would be useful for employers to understand more about OC and PC since it is likely that this knowledge would help to empower them to strategically enhance workplace characteristics with the aim of achieving the benefits associated with a committed workforce.

## 1.2 Statement of the Problem

Recently psychological wellness, health and safety in the workplace have garnered increased attention from Human Resources, OHS, legal and other groups. Psychosocial hazards in the workplace are linked to depression and financial losses (decreased production, absenteeism, presenteeism, human error etc.). Ergonomics as a field is commonly understood as being relevant only to the physical domain, dealing with musculoskeletal injury prevention, and as being practiced primarily in the Occupational Health and Safety field or in Disability Management. Theberge and Neumann (2013) concluded "an irony of the dominant understanding of ergonomics as oriented to safety is that this provides the main basis for its growing presence in workplaces but also limits its applications" (p.403). Ergonomics, however, can be used to help with preventing psychosocial hazards in the workplace through job design and organizational systems design practices. The problem is a matter of whether the field is sufficiently recognized as such, and what it might take to improve that recognition.

## 1.3 Justification

The Conference Board of Canada Report (2012) reported that mental illnesses are taking their toll in Canadian workplaces, and that everyone stands to gain if workers can be assisted by their employers to remain functional at work. "Everyone" includes the workers, the firms and the Canadian economy.

The Ergonomics profession would benefit from ensuring that its practitioners recognize what ergonomics offers in the area of workplace psychosocial factors. This is not to say that each individual ergonomist should be practicing in all areas of the field at once (as this is neither practical nor effective). Instead, EPs should be aware of, and routinely include consideration for the broad implications of the field in their work, rather than to approach problems in a "single problem-single solution" manner. Wilson (2014) stated that in his editing work for a number of journals, he is exposed to numerous EP's reports, which "far from actually analysing or investigating at a system-level, do not even acknowledge the importance of context, which influences the interactions between the researchers' focus and other parts of the system in practice" (p. 5).

There may be a need to enhance the current understanding of ergonomics by its practitioners (among others), for the profession to advance itself. It would be beneficial to identify what form of support (if any) EPs require in their work environment in order to further enhance their understanding of how ergonomics is related to psychosocial hazards in the workplace.

Currently there is a regulatory framework in Occupational Health and Safety (OHS) that addresses MSIs in the workplace to different degrees across the country. Although there could be a variety of approaches to attempt to improve psychological safety and health in workplaces, it is conceivable that it could become the topic of further regulation, and that this might be coupled with the currently available MSI prevention regulations. If this were the case, and ergonomics related regulations were to be utilized as a vehicle to regulate psychological health and safety in workplaces, it would be beneficial to understand how Ergonomists and others perceive the breadth of the field to do so.

Finally, the ergonomics profession itself can benefit when further insight is gained into how it is perceived by various professional groups who practice ergonomics, in the context of psychosocial hazards in the workplace. This knowledge can be added to the growing body of historical perspective literature in the field, and help to provide direction to the field's professional development.

## 1.4 Conceptual Framework

Ergonomics is described by the IEA as having three domains of specialization: organizational, cognitive and physical ("What is Ergonomics", n.d.). The perception by the public and by many professional groups as identified by their representatives in literature, tends to be an active separation of organizational and cognitive from physical domains into Human Factors and Ergonomics respectively. This may result in severing the perceived relation between ergonomics and psychosocial hazards control in the workplace, relegating that task to "Human Factors" (if at all), and leaving only an

association of Ergonomics with the task of reducing MSIs. The current connection is more popularly made in terms of how psychosocial hazard control in the workplace serves to help to control the onset of MSIs in the workplace.

The relationship between ergonomics, human factors and the domains of specialization is depicted in Figure 1. The preferred relationship model for the interaction of the domains of specialization of ergonomics (where human factors and ergonomics are considered to be one field) is illustrated in Figure 2. If the areas of practice in ergonomics, and how they work together to produce benefits, are not clearly enough understood by EPs, then missed opportunities in organizational systems and job design, public policy and occupational health and safety could result (as illustrated by the "psychosocial hazards, no MSIs" section in Figure 2).

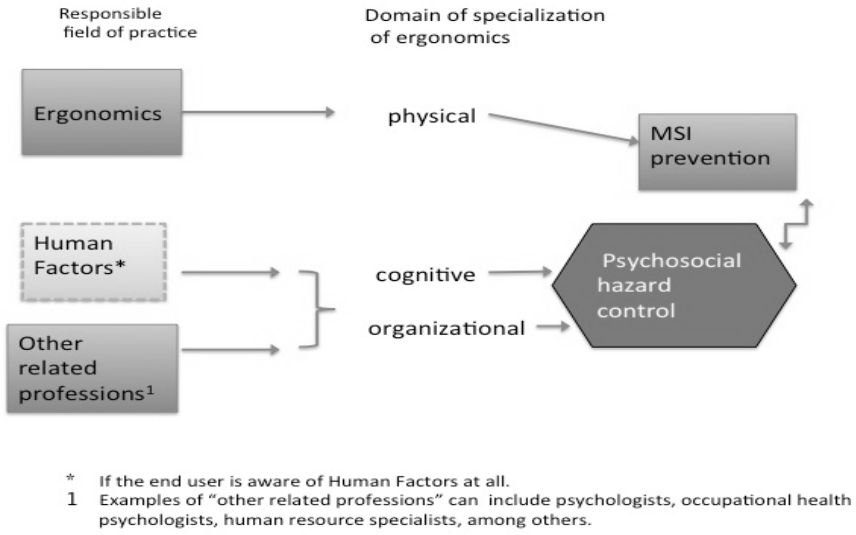


**Figure 1 Common perception of the relationship between ergonomics and psychosocial hazards control**

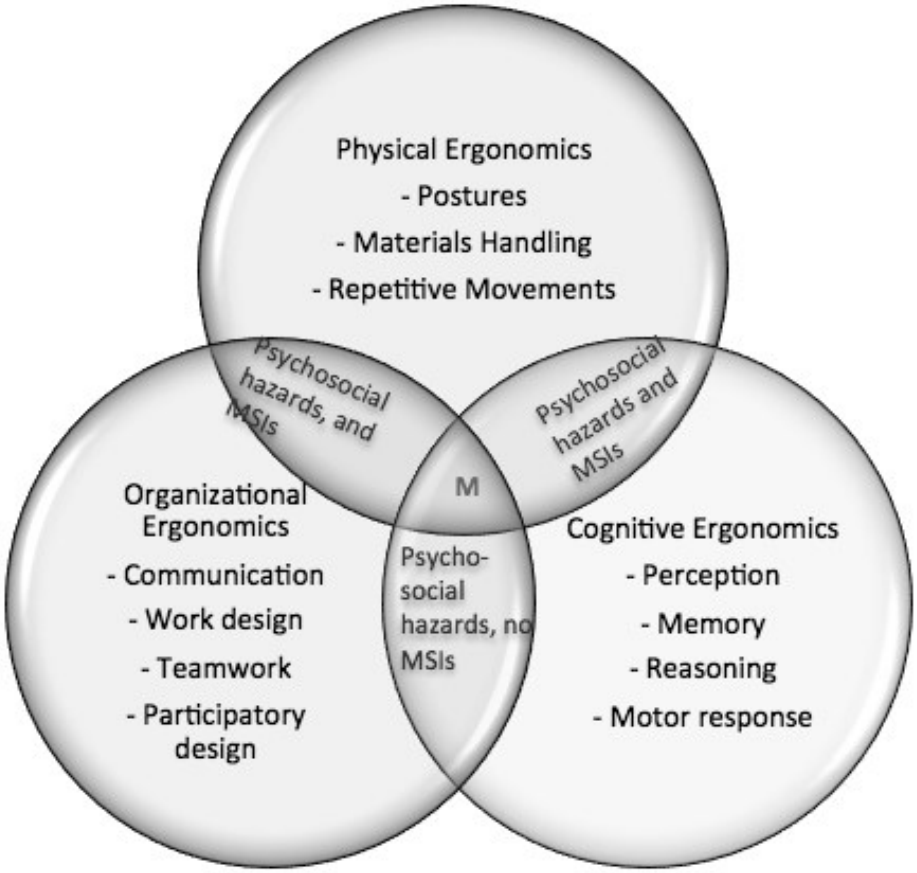


**Figure 2 Desired understanding of the relationship between areas of practice in the ergonomics field and psychosocial hazards versus MSI where M = Macroergonomics**

## 1.5 Study Objectives

The purpose of the study is to assess the "awareness" of EPs. It seeks to explore their degree of PC versus OC and the possible relationship with their "awareness" level. Lastly, it seeks to clarify the relationship between employer support (defined in this study as access to professional development and to peer reviewed journals), and the EP's "awareness".

The aims of this study are to:

- add to the growing body of literature describing the state of the ergonomics field and its evolution,
- identify a possible weakness in the current ergonomics-practicing environment in Canada,
- highlight possible employment conditions which would benefit EPs and their employers,
- help to identify whether general awareness of the field's relationship with psychosocial hazards control needs strengthening.

## 1.6 Research Hypotheses

The following hypotheses are considered in this thesis:

Hypothesis #1: Do EPs demonstrate awareness of a direct relation between the application of ergonomics and the control of workplace psychosocial hazards (independent of MSI consideration)?

Hypothesis #2: Do EPs who are aware of the relation between ergonomics and workplace psychosocial hazard control have a stronger commitment to their profession or to their employing organization?

Hypothesis #3: Is there a relationship between having an employer's support (i.e. access to peer reviewed journals and professional development opportunities) and an EP's awareness of the relation between ergonomics and workplace psychosocial hazard control?

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Evolution of the field

### 2.1.1 How ergonomics obtained its breadth.

"People have been practicing Ergonomics ever since the first person fashioned a tool or devised a better method to do something that was previously slow, difficult or painful to accomplish. People have also been practicing ergonomics when they came together in groups to "share the load" during lifting, or to alternate work tasks to decrease boredom and monotony" (Brewer & Hsiang, 2002, p. 289). In the late 1600s and early 1700s, Bernardino Ramazzini studied illnesses and injuries identified with specific occupations and presented remedies that included eliminating awkward postures, alternating activities, improving, for example, tools and lighting (Girault, 1998). Wilson (2000) points out that formal consideration of the interactions between people and their working environments can be found in literature about 100 years old. The historical perspective of ergonomics reveals an evolving and growing profession.

The basic premise of Ergonomics is to consider the abilities, needs and limitations of humans while placing them at the center of design, i.e. human centered design. This applies to designs or design changes of any type, including human-computer interface, workstations, tasks, jobs, organizations, systems and products among other things. As our organizational / work environment and the nature of our interactions with it change and evolve; so too does the field of ergonomics.

In 1958, Christensen wrote that the field of Human Factors was confronting some new issues in its development. His predilection was that the difference between an outstanding system and a mediocre one is the inclusion of humans as a subsystem within the design, but that this would not be realized without the Human Factors professionals' involvement in realizing the human subsystem's full value. This perspective was not quickly popularized however.

Hendrick (2002) stated that during the first three decades of the ergonomics discipline (roughly the 1950s, 60s and 70s) the focus was primarily on "optimizing the interface between individual operators and their immediate work environment" (p.5). The aim was to enhance health, safety, comfort and productivity. Work from this perspective was later termed to be "micro-ergonomics", and included a strong emphasis on physical considerations, among others.

Dempsey, Wogalter and Hancock (2000) studied the many names and terms recognized as defining and describing ergonomics at that time, with the aim of examining the foundational basis of the field. They found that the most representative definition might be, "the design and engineering of human machine systems for the purpose of enhancing human performance"(p. 6). Also in 2000, the IEA defined Ergonomics as being "the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize human well being and overall system performance" (IEA, n.d. a).

A clear difference between the IEA definition and that proposed by Dempsey et al. (2000), is the obvious inclusion by the IEA of the aim to optimize human well being and system performance as opposed to the more singular aim of enhancing human performance, proposed by Dempsey et al. It could be argued that human performance is what ultimately optimizes overall system performance, however in the IEA's definition it is not left for debate.

The IEA recognized three domains of specialization in ergonomics, or "application domains"; physical, cognitive and organizational. These are not considered to be mutually exclusive, "and they evolve constantly; new ones are created and old ones take on new perspectives" (IEA, n.d. b).

Physical ergonomics was defined as being "concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. The relevant topics include working postures, materials handling, repetitive movements, work-related musculoskeletal disorders, workplace layout, safety and health" (IEA, n.d. c).

Two of the three domains of specialization in ergonomics (cognitive and organizational) had begun to emerge and become specifically recognized as such, in the 1980s as the field of ergonomics continued its evolution. The IEA has defined cognitive ergonomics as being "concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system" (IEA, n.d. c). The relevant topics include mental workload,

decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design." Organizational ergonomics was defined as being "concerned with the optimization of sociotechnical systems, including their organizational structures, policies, and processes. The relevant topics include communication, crew resource management, work design, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work paradigms, organizational culture, virtual organizations, telework, and quality management" (IEA, n.d. d).

Cognitive ergonomics had become more clearly identified as a domain of specialization in response to the rapid development of computers and automation in workplaces in the 1980s. It was first centered on software design (Dray, 1985) with an emphasis on how humans think and process information for purposes of improved human-software interaction. This interaction needed to minimize or prevent the opportunities for human error, and to promote productivity.

An example of how ergonomics was being integrated into the pursuit of improved productivity through cognitive ergonomics was the research of Freeley and Freeley (1984). They identified the need to examine the productivity of white-collar workers and how that measurement would be made. It was argued that due to the nature of their work, organizational attempts to optimize the white collar workers' productivity was dependent upon understanding the workers' work preferences, and furthermore, that those preferences should be fulfilled wherever feasible.

Based on a review of presentations made at the IEA conferences since 1961, Waterson, Falzon and Barcellini (2012) were able to show the increasing academic and practical information that ergonomists have been providing in the "cognitive ergonomics" area. The number of relevant presentations was shown to have grown significantly over the years, where in 1961 very few presentations, if any, were focused on cognitive ergonomics.

Systems-thinking in the ergonomics community of practitioners has been evolving into the mainstream, together with the ongoing changes in the nature of technologies, demographics, values, global markets and other factors in workplaces (Hendrick, 2002). In 1958 J.M. Christensen reported that the human factors specialist "must take a continuing, active interest throughout planning, design, development/testing and operational use of systems" (p. 7). As a result of having to consider the various contributors and factors in work systems, the practice of ergonomics began to evolve from a "micro" perspective to a "macro" approach. Hendrick (1991) stated that to design appropriate user centered systems, all of the elements must be taken into account as opposed to adopting a micro approach, and that it is effective design which drives much of the microergonomic design within a system.

Hollnagel (1997) reported that there are two types of ergonomics; "classical ergonomics" (better known as "occupational biomechanics" or "industrial ergonomics") and "cognitive ergonomics" (concerned with quality of work). But even Hollnagel ends

by saying “they should be used together to address, understand and solve the problems of work” (p.1182), i.e. the problems of the work system.

In 1980 the Human Factors and Ergonomics Society (HFES) (formerly the Human Factors Society) formed a “Select Committee on Human Factors Futures, 1980-2000”, which researched trends related to the management and organization of work systems. The findings were presented in a report by Hendrick in 1980, as cited by Hendrick (2002), where it was concluded that “for the human factors/ergonomics discipline to be truly effective, and responsive to the foreseeable requirements of the next two decades and beyond, there is a strong need to integrate organizational design and management (ODAM) factors into our research and practice.” In North America, in 1986, the ergonomics of work systems became formally identified as macroergonomics. Its European counterpart was known as “systems safety” (Kleiner, Hettinger, Dejoy, Huang & Love, 2015).

Robertson, Kleiner and O’Neill (2002) clearly utilized cognitive and organizational ergonomics in a macroergonomics application for an office environment with health and performance problems. They showed a method of assessing work system processes using a “problem factor tree” which listed contributing factors to health and performance problems. Those factors included organizational factors such as lack of job content, poor job design and a lack of flexible workstation design and environment. Another popular approach in the practice of ergonomics from a systems approach, is Participative Ergonomics (PE) which is an approach or a method that uses worker

participation to implement macroergonomics (Brown Jr., 2002). There is a rich body of information showing how PE has been implemented, in order to achieve improved ergonomics in a system (Antle, 2008; Bustos, Fischer, Bellardin, Nielson, 2012; Carrick, Lee, Yau & Stevenson, 2005; Driessen et al., 2011; Eklof, Ingelgard & Hagberg, 2004; Jatckak, 2008; Laing et al., 2007; Tappin, Vitalis & Bentley, 2016; Woodcock et al., 2009 ).

Holden, Rivera and Carayon (2015) reflect on the articles included in a special edition of IIE Transactions on Occupational Ergonomics and Human Factors, and how macroergonomics represents the systems-thinking which is embraced by the global ergonomics community. Systems ergonomics, which accounts for much of the philosophy behind macroergonomics, has been practiced in Europe for 50 years (Kleiner, 2006). The breadth and depth of the ergonomics field can be well demonstrated by considering the "system" which it is intended to address. Kleiner et al. (2015) describe a system as follows:

> A work system then is one that involves (1) two or more persons, interacting with some form of (2) technology (hardware and/or software, procedures), (3) an internal work environment (both physical and cultural), (4) external environment (with nested sub-environments) and (5) an organisational design and management subsystem. The hardware typically consists of machines, tools and tasks. The internal environment consists of various physical parameters, such as temperature, humidity, illumination, noise, air quality and vibration; it also includes

> psychosocial and cultural factors. The external environment consists of those elements that permeate the organisation to which the organisation must be responsive to survive and be successful (analogous to environmental forces in biology). Included can be political, regulatory, technological, economic, educational and cultural sub-environments. (p. 641)

Hendrick (1991) wrote that the lack of compatibility of the worker with the system's technology and structure, which comes as a result of using only microergonomics approaches, "not only directly adversely affects system productivity and efficiency, but employee motivation, commitment and intrinsic job satisfaction as well" (p. 753). Through its own methods and tools, macroergonomics attempts to achieve a fully harmonized work system at both the macro- and microergonomic level (Hendrick, 1995). This is possible especially when the relationships between ergonomics variables at the micro and macro levels of a system are recognized (Zink, 2000). An example of these relationships could be the suddenly increased physical demands during a receiver's work due to the actions undertaken by someone in another department within the organization "stocking up" (ordering too many supplies). The expected results of achieving a harmonized work system at both the macro- and microergonomics level are improved productivity, job satisfaction, health and safety, and employee commitment (Kleiner et al. 2015).

### 2.1.2 Future applications (why it needs to continue to evolve)

As information technology and methods continue to evolve and create new work environments, and as safety engineering, organizational design, management practices and other related fields evolve with the changing environments, so too will ergonomics. Ergonomics by definition can provide a comprehensive, problem-solving approach. Zink (2000) suggested that in order to broaden the scope of the discipline, employees, customers, shareholders and society should all be considerations in the macroergonomics approach, and that this is already a reality in some countries.

Further development of the field of ergonomics into other areas is very likely; it evolved following World War II with "human performance" studies, and again when cognitive psychology allowed for the inclusion of cognitive engineering in the design process (Posner, 2012). The study of brain and behaviour at work is referred to as "neuroergonomics" and this can be applied in the context of understanding brain function and how it relates to human performance in specific practical tasks (Parasuraman, 2003). Through the synthesis of neuroergonomics and physical ergonomics, important information could be derived to help prevent musculoskeletal injuries amongst other applications (Karwowski, Siemionow & Gielo-Perczak, 2003). In 2011, Lees, Cosman, Fricke, Lee and Rizzo showed us how steady improvement in neuroimaging methods have led to significant improvements in how cognitive neuroscience research can be used, such as to improve the design of automobiles and the safety of drivers.

Sustainability issues involving natural resources, infrastructure systems and

standards of living including working conditions, are prevalent in the mainstream media and in the literature. Martin, Legg and Brown (2013) concluded, "the contribution of ergonomics to sustainability and sustainable design has been limited, even though the goals of sustainability and ergonomics are congruent. Ergonomists have not been at the forefront of research contributing to sustainability" (p. 365).

Still another application for ergonomics is outlined by Nickerson (2011), showing how ergonomics has to meet the challenge of terrorism through the involvement in design of security systems, evaluation of preventative measures, training, and studies on how people under stress behave. Along an even broader line of thinking, it has been said that ergonomists should have within their training, political, social and economic studies, in order to better understand the systems within which the work is taking place on a meso or macro level (Moray, 2000).

As identified by Thatcher and Yeow (2015), a number of researchers and authors have suggested that the ergonomics profession needs to "look beyond a bounded system and reductionist approach to ensure its own sustainability by being inclusive of contributions from disciplines in the social, management, biological and ecological sciences" (p. 9).

It is clear from many reviews, editorials, studies and books on the history of ergonomics and how it is applied not only historically but today and into the future, (Bentley & Tappin, 2010; Boff, 2006; Brewer & Hsiang, 2002; Caple, 2010; Christensen, 1958; Dul et al., 2012b; Helander, 1997; Hendrick, 2000; Hollnagel, 2012; Karwowski,

2005; Kubek et al., 2015; Lange-Morales, Thatcher and García-Acosta, 2014; McDonald, Ward & Morrison, 2012; Meister, 1997; Moray, 2000; Parasuraman et al., 2012; Posner, 2012; Shorrock & Murphy, 2005; Thatcher & Yeow, 2015;Waterson & Sell, 2006; Wilson, 2000; Wilson, 2014; Wilson & Carayon, 2014; Zink & Fischer, 2013) that ergonomics has for a very long time already, been about far more than humans' physical interactions with their immediate workstations for MSI reduction. It has moved well beyond that narrow application. The question is whether EPs will represent the profession as such, or if there is a danger that due to a collectively low "awareness" (regardless of areas of specialization in the field), we are not united in how we portray the profession, the field and its possible applications and benefits.

### 2.1.3 Evolution of the name

From the beginning of the field's emergence as a discipline, there has been a debate on how it is to be referenced; ergonomics or human factors. Even amongst Ergonomists there is not a clear unity on the appropriate title. Some Ergonomists are very much devoted to the concept that both titles exist separately for good reason. For example, it is recognized by the ACE, (the IEA's federated society in Canada), that there is a fundamental difference between "human factors" and "ergonomics" amongst the French Quebec membership of the Association, whereas amongst the English membership there appears to be less of a distinction made. There is a francophone "ergonomics" approach (Carayon et al., 2015; Daniellou, 2005; Filliettaz, Billet, Bourgeois, Dunard and Poizat, 2015), which may contribute to the difference in interpretation of the titles between francophones and anglophones.

The UK's Chartered Institute of Ergonomics and Human Factors notes on their website, "As the discipline evolved, some variations in terminology arose in different countries. In the USA the term Human Factors took on the same meaning as Ergonomics in the UK. The argument that human factors and ergonomics are two names for the same field is common, however the fact that there are two names for what could be perceived as being the same area of practice has possibly stalled the field's progress and limited understanding of the full breadth of ergonomics by its practitioners, and the general public" (Chartered Institute of Ergonomics and Human Factors, n.d.).

According to the ergoWeb website, "areas of knowledge that involved human behavior and attributes (i.e., decision making process, organization design, human perception relative to design) became known as cognitive ergonomics or human factors. Areas of knowledge that involved physical aspects of the workplace and human abilities such as force required to lift, vibration and reaches became known as industrial ergonomics or ergonomics" (ergoWeb, n.d.). In 2009, the UK's Ergonomics Society was renamed the Institute of Ergonomics and Human Factors (IEHF) to reflect the popular usage of both terms and to emphasize the breadth of the discipline.

The Human Factors Society was formed in the U.S. in 1957 (at the time named the Human Factors Society of America), and by 1992 had changed their name to the Human Factors and Ergonomics Society. The Human Factors Association of Canada was formed in 1968. The name was changed to the Association of Canadian Ergonomists in 1999, and as of 2014 discussions have been prevalent at annual meetings, to once again

consider a name change to encompass both terms in the name as opposed to one or the other.

It is likely that the breadth of the field attracts the desire to differentiate different applications of ergonomics by renaming them (e.g. forensic ergonomics, rehabilitation ergonomics, engineering ergonomics, design ergonomics etc.). This approach may be helpful in describing the field's many applications, and it may be helpful when applying for funding or other resources that must be very clearly demonstrated to be relevant to a particular application. This separation of meaning is one of the dangers in having the "domains of specialization" outlined by the IEA. The positive benefits include being able to demonstrate the breadth of ergonomics to all manner of audiences. If however, readers overlook the caveat that these domains do not exist in isolation and that they continually evolve with changes in workplaces and workforces, there is a possible misunderstanding about their essential connectedness and the role they all play in a true systems oriented approach. Unfortunately however, a field such as ergonomics, whose meaning is not immediately clear, may need explaining.

The term "holistic ergonomics" was coined as a "new approach" (O'Neill, 2010), apparently to describe the use of ergonomics in a manner that would encompass both engineering and cognitive based ergonomics. This description seems to entirely overlook the fact that ergonomics is in fact holistic by definition (Kleiner, 2006; Wilson, 2000; Wilson, 2014; Zink, 2000) and has been developing further since the mid 1980s as a systems science, with the goal of encompassing all of the elements of a work system,

including how people interact with one another and with their environment, and how the systems within which they work interact with other relevant systems. The holistic/systems-driven approach is a bedrock of ergonomics and is what provides its strength according to Wilson (2000). Adding yet another title to the nomenclature collection for one field and its application could add to the confusion, although one can not be blamed for the temptation to cite the word "holistic". When Williams and Haslam (2011) involved ergonomists from a variety of backgrounds (i.e. EPs) to discuss what characteristics an ergonomist should have, having a holistic/systems-driven approach was common to each focus group of participants.

## 2.2 What is an Ergonomics Practitioner (EP)

Practitioners of ergonomics, Ergonomists, contribute to the planning, design and evaluation of tasks, jobs, products, organizations, environments and systems in order to make them compatible with the needs, abilities and limitations of people" (IEA, n.d. a).

Rice and Duncan (2006) argued that there are six generally accepted criteria for what it means to be a professional Ergonomist. One of those criteria was that an ergonomics professional must master a complex body of knowledge and skills. This would include a formal education in ergonomics and subsequent practical experience in the field such as is stipulated in professional Ergonomist certification programs. Another of the criteria is to exhibit a professional spirit and to contribute to the advancement of the professional group. (For a review of all six criteria, see Rice and Duncan, 2006).

Ergonomics Practitioners (EPs) who are not certified Ergonomists may well be exhibiting the criteria for a professional but not necessarily specific to the profession of ergonomics.

Ergonomics Practitioners (EP) include practitioners from a wide variety of academic backgrounds. The profession itself, ergonomics, is not a regulated profession in many countries and as a result in those countries, the term "Ergonomist" is not a legally protected title. In 2014 the Chartered Institute of Ergonomics and Human Factors in the U.K. was awarded a Royal Charter, which allows the titles now be protected in the U.K. Regulated professions are those, which the government deems capable of harming the public through malpractice. Many professions are regulated, such as medical physicians, engineers, occupational therapists, medical laboratory technicians and many more. In order to be a member in good standing of any regulated profession, there are admission requirements usually including a requirement to meet certain criteria (usually academic and professional in nature) resulting in becoming licensed as a member of that profession.

In the absence of regulations, the professional associations representing Ergonomists in the world have developed professional certification procedures. Their objective is to provide consumer protection through promoting a degree of quality assurance and professional credibility with regards to the credentials of professional "Ergonomists", (Smith, 2012). The professional certification processes provide a context and foundation upon which to develop and practice the professional criteria outlined by Rice and Duncan (2006). The titles of most professional certifications are protected, however there is currently no legal requirement for people to obtain any certification

before being allowed to refer to him or herself as an Ergonomist in most parts of the world. As a result, there are people practicing ergonomics with very limited appropriate training or experience who would not qualify for the certification and do not meet Rice and Duncan's (2006) six criteria for a professional ergonomist. There are also many people who are very qualified and experienced ergonomists who have chosen not to obtain the certification for a variety of reasons. These are people who are likely practicing Ergonomists, and they may be (or may be able to) meet Rice and Duncan's (2006) six criteria for an ergonomics professional, however without participating in the certification process, some of the criteria may be more difficult to follow or at least not as clearly present to the public as when a professional certification is obtained. The outcome is that there are many EPs, some of which may or may not be fully aware of the breadth of the field, and of its potential for benefit in a wide variety of applications including controlling psychosocial hazards in the workplace.

Many EPs practice ergonomics as a part of their regular duties and do not choose to become certified Ergonomists or even to refer to themselves as Ergonomists, since their positions include a wide variety of demands, many of which are not ergonomics related. For example Industrial Hygienists may identify ergonomics-related issues in workplaces, but only as one of many other environmental factors or stresses arising out of work such as chemical or biological exposures. They likely identify themselves in most cases, as Industrial Hygienists, not Ergonomists. Some professions commonly associated with practicing ergonomics as a part of their work in Canada are Kinesiologists,

Occupational Therapists, Physiotherapists, Industrial Hygienists, Industrial Engineers and Occupational Health and Safety professionals.

Given the circumstances, it is clear that there could be some very different perceptions about ergonomics amongst EPs. Even amongst certified Ergonomists, there are a variety of academic backgrounds since the field itself covers such a breadth of application.

As noted earlier, there are options for individuals who primarily use or practice ergonomics in their work, to become certified in the field. "Canadian Certified Professional Ergonomist" (CCPE) is a certification obtained through the Canadian College for the Certification of Professional Ergonomists (CCCPE) and "Certified Professional Ergonomist" (CPE) is a certification obtained through the Board of Certification in Professional Ergonomists (BCPE) out of the U.S.A. In a review of professional Ergonomist certification programs available world wide, Smith (2012) found a range of ratios of certified Ergonomists to every million citizens (M) in the related country's population. The range was from 9.27/M in the U.S.A. to .51/M in Brazil. Canada had the second highest ratio, with 4.74/M based on 161 CCPEs at that time. As of the writing of this paper there were 213 CCPEs. Conceivably there are more than 213 EPs in Canada alone, since 213 EPs are not likely to be responsible for all of the ergonomics related work done in the country! CCPEs in Canada then, are far less in number than EPs who are either not certified at all, or who are licensed or certified in other professions and practicing ergonomics as a part of their work. Figure 3 shows how

few certified professional Ergonomists there are compared to other licensed or certified professional groups that might practice ergonomics. Given their numbers, it is likely that the perception of ergonomics, held by those who do not describe themselves as Ergonomists (but who practice some ergonomics), has a significant influence on the image and direction of ergonomics as a profession.

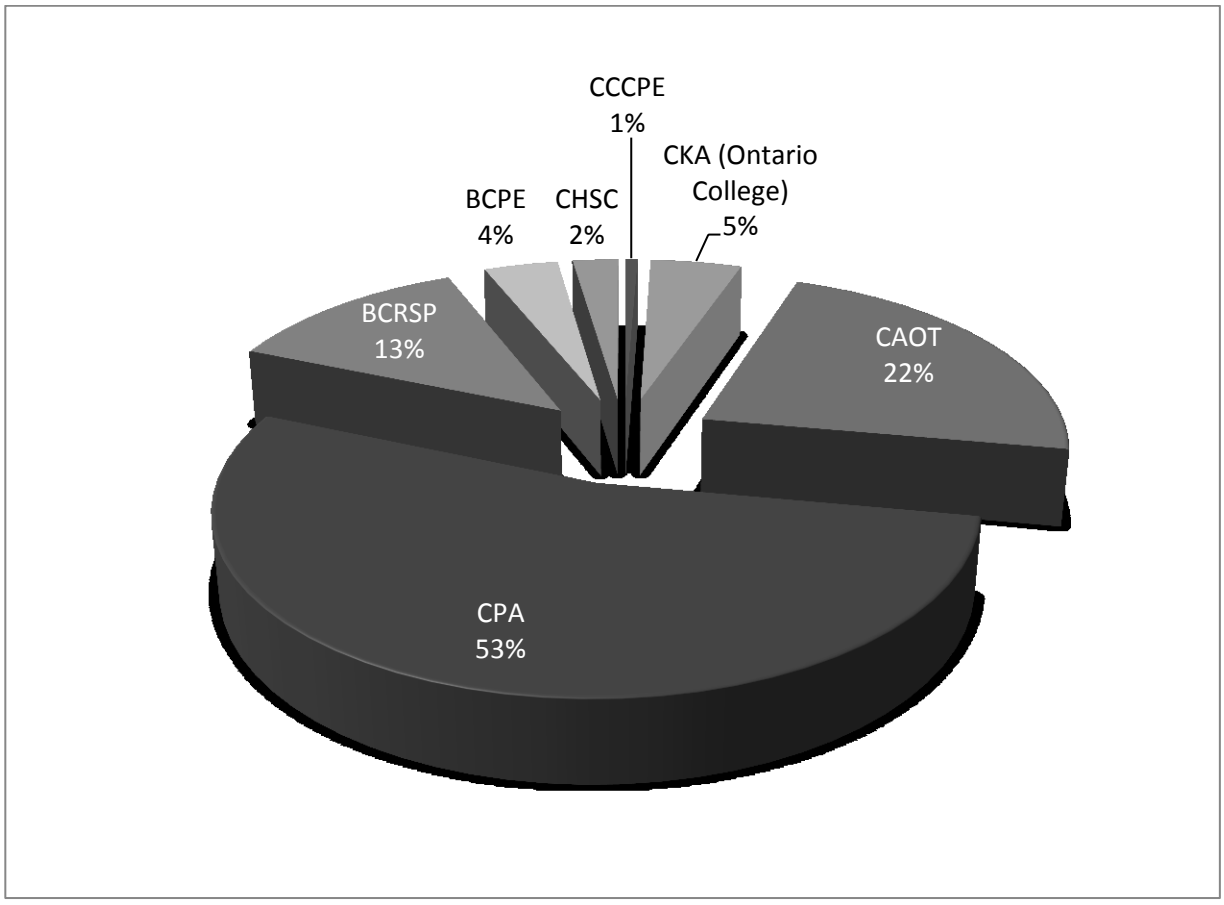


**Figure 3: Percentage of certified Ergonomists (CCPEs and CPEs) versus the percentage of other certified professionals that might also practice ergonomics in Canada, where 100% = all numbers of certified EPs in each association at the time of the writing of this paper.**

## 2.3 How is ergonomics perceived?

In 2011 the IEA's Future of Ergonomics Committee (Dul et al., 2012a) presented their report wherein they noted that "the very strength of HFE, its multidisciplinary base, is also a potential weakness; a diversity of topics, views and practices exists within the HFE community, resulting in sending unclear messages towards the external world" (p. 2). Wilson (2012) in his personal description of the challenges in the field over the last 25 years, stated that in the 1980s, people in the field who had come from a computer science or cognitive psychology background, had a mistaken perspective that ergonomics was primarily a physical application, not cognitive. Howell (2003) observed what could have been a possible result of this situation, which he described in his contribution to the Handbook of Psychology. His description read, "neither the field of ergonomics nor its contributions are widely appreciated by the general public, its elected officials, organizational decision-makers, or even the field's own parent disciplines of psychology and engineering" (p. 546). Dul et al., (2012b) point out that in a recent cover story of one of the most influential management journals, the author envisions that psychology has a role to play in the joint optimization of well being and performance. There is no mention in the article of ergonomics or human factors, despite the glaring similarity of ergonomics, to their topic of interest.

Howell (2003) identified a distinct lack of awareness of ergonomics by the psychology profession. Not a lack of awareness of research outcomes or of ergonomics being applied in the workplace in general, but of the actual profession itself; of Ergonomists. An interesting finding in a survey to employers of ergonomists by

Rantanen and Moray (2012) was that companies often hire "general" psychologists to do HF/E work, but that their HF/E-specific training is limited to a summer short course or something similar in nature. It begs the question that if there is recognition that general psychologists might also be EPs, then shouldn't there also be an understanding that an EP might be very adept at dealing with the psychosocial hazards in the workplace?

Although public awareness of the word ergonomics has increased, the understanding of the word is limited (Budnick, 2001). Many people appear to consider the fitting of office workstations to workers (office ergonomics), or proper lifting techniques to be the defining subjects of ergonomics. Some of the literature regarding the effects and causes of psychosocial hazards, which also references ergonomics, does so only with regards to the physical changes made to a workstation or a lifting task (i.e. recognizing only physical ergonomics), and overlooks other applications of ergonomics for example Kim, 2014; Miles, 2000; Sauter, Murphy, Hurrell, 1990 and Sung, 1999.

Even more prevalent are the studies that intentionally seek the connection between MSIs and psychosocial hazards. A very strong link has been established between the presence of psychosocial hazards in the workplace and either the onset, or the sustained presence, of MSIs (Bongers et al., 2006; Driessen et al., 2011; Faucett, 2005; Kerr et al., 2001; Lang, Ochsmann, Krauss & Lang, 2012; Leroux, Brisson & Montreuil, 2006; Thiese et al., 2015; Vandergrift, Gold, Hanlon & Punnet, 2012). Studies of this nature can be found in a number of well known ergonomics journals listed in the EJL 2005 (Dul, Karwowski and Vinken, 2005), such as *Ergonomics* (Ahlgren, Malmgren Olsson &

Brulin, 2012; Devereux, Rydstedt & Cropley, 2011; Hughes, Babski-Reeves & Smith-Jackson, 2007), *Human Factors,* (Carayon, Smith & Haims, 1999; Gerr et al., 2014; Miranda, Punnett, Gore and the ProCare Research Team, 2014; Nelson & Silverstein, 1998;), *Applied Ergonomics* (Eatough, 2012; Warming, Precht, Suadicani & Ebbehøj, 2009; Widanarko, Legg, Devereux & Stevenson, 2014), *International Journal of Industrial Ergonomics*, (Choobineh, Motamedzadi, Kazemi, Moghimbeigi & Heidari Pahlavian, 2011; Govindu & Babski-Reeves, 2014; Nimbarte, Al Hassan, Guffey & Myers, 2012) and *Human Factors in Ergonomics and Manufacturing,* (Collins & O'Sullivan, 2010).

An example of the type of studies undertaken is Kerr et al., (2001) who concluded that significant strengths of association between work-related psychosocial and biomechanical variables exist. The study concluded that workplace programs aimed at preventing low back pain would be most effective if the focus of the program were on both the psychosocial and the physical aspects of work.

Possibly as a result of this type of strong exposure in the literature between MSIs and psychosocial hazards, or due to ergonomics being equated to mainly physical changes to workstations in research, some EPs may recognize the relation between ergonomics and psychosocial hazards only from the MSI prevention perspective. The relation between ergonomics and psychosocial hazard control however, does not have to be a physical, MSI related, change. It could be an organizational or job design modification resulting in psychosocial hazard control and not necessarily a direct attempt to control

MSI (Bao et al., 2015; Petit and Dugué, 2012). The issue may be further complicated by the "Ergonomics vs. Human Factors" debate where the assumption is that what IEA refers to as "cognitive ergonomics" and "organizational ergonomics" are understood to be the domain of Human Factors, and that "physical ergonomics" belongs to "Ergonomics".

The field of Occupational Health Psychology (OHP), which began to be identified in the professional literature in 1990 (Raymond, Wood & Patrick 1990), consists of practitioners who come from varied backgrounds (Adkins, 1999). Adkins (1999) reports that one of the unifying principles in OHP amongst the varied professions, is that "the underlying conceptual framework for OHP emerged from work in occupational stress and psychosocial risk management" (p. 129). OHP is "the interdisciplinary partnerships of psychological and occupational health science professionals seeking to improve the quality of working life, and enhance the safety, *health and well-being of workers* [emphasis added] in all occupations. Because it exists at the intersection of behavioral science and occupational health disciplines, OHP is inclusive of knowledge and methods from psychology, public/occupational health, organizational studies, *human factors*, [emphasis added] and allied fields" (Society for Occupational Health Psychology, n.d.).

In the Handbook of Occupational Health Psychology (Quick & Tetrick, 2003), ergonomics is discussed regularly as one might expect from the clear relationship between the two fields as previously described. On each occasion however, it is referred to strictly in the context of its physical domain. Although the topic at hand is occupational health psychology, no reference is made to the cognitive/organizational

aspects of ergonomics and how they could apply to prevention of work related stress. Similarly, very little mention is made of the cognitive/organizational aspects of ergonomics in, Barling, Kelloway and Frone's Handbook of Work Stress (2005). Interestingly however, contributors Jex and Crossley (2005) note in their chapter "Organizational Consequences" that their current understanding of occupational stress has benefited from those trained in human factors (amongst other areas), and that "collaborations among researchers in these areas are also necessary for a comprehensive understanding of organizational consequences of work stress" (p. 595). This is very encouraging, even though human factors is specified and ergonomics is not, indicating a distinction again both here and throughout the rest of the book. The exception however, is the chapter by Coovert, Thompson and Craiger (2005) who include cognitive ergonomics and the history of psychology in ergonomics. Even in this description however, the description of ergonomics does not include organizational concerns, or the systems perspective. Instead, the socio-technical systems perspective is described separately from ergonomics, even though macroergonomics was already at that time taking on a primarily sociotechnical perspective (Hendrick & Kleiner, 2002).

In a guide developed for Human Resources professionals by the National Safety Council, (2004) ergonomics is defined with reference to being an "ergonomic hazard which will result in physical harm or injury caused by improperly designed tools, work areas or work procedures" (p. 21). In the Occupational Health and Safety profession, a popular understanding of ergonomics is that it is related primarily to the prevention of MSIs. Possibly as a result of this type of legislative activity, around MSI prevention in

Canada, there is a proliferation of Occupational Health and Safety Programs that include an "ergonomics" section, which is limited to providing a set of rules on how to safely lift, or how to safely sit and work at a computer. This is not surprising, given the findings of Theberge and Neumann (2013) where they found strong support for the view that ergonomics is primarily associated with OHS in Canada. They expressed concern with the placement of Ergonomists in their organizations' OHS departments, perpetuating the OHS relationship with ergonomics. They suggested that "in effective ergonomics applications, safety and productivity are joined in the production process and ergonomists have a main role to play in advancing both agendas" (p. 406). Interestingly, Lamm, Massey and Perry, (2007) reference ergonomics as being one of the disciplines wherein there has been the most sustained and notable examples of linking OHS and company productivity over the last decade (as well as occupational medicine/health promotion). Clearly there is still an OHS focus in this perspective of ergonomics, and it is associated with productivity and performance.

There is an undeniable link between ergonomics and OHS, however OHS professionals clearly often perceive it as being MSI-prevention related. This is not to say that there is no value in this relationship. PE has been used to successfully implement MSI prevention strategies, and this depends upon better integration with OHS management systems according (IWH, n.d). "Safety culture can either directly influence the nature and effectiveness of ergonomics interventions within a work system or can influence these indirectly through the organization's OHS management system" (Bentley

& Tappin, 2010, p. 1170). These ergonomics interventions are not necessarily all MSI related however.

In 1996 Daniel Petersen introduced the 3rd Edition of his book "Human Error Reduction and Safety Management" by noting that the safety management field has had a paradigm shift since 1982. This paradigm shift includes safety management's collective recognition of ergonomics, "as well as the reference to psychosocial stress" (p. ix). This recognition of ergonomics (and human factors) came fully 43 years after it had been recognized by physiologists and psychologists who in September 1949, formed the Ergonomics Research Society in the UK (Waterson et al., 2012; Waterson & Sell, 2006).

Bentley and Tappin (2010) argue that the Ergonomist should be concerned with, and actively measuring, the safety culture of an organization as one of the first steps of their work within that organization. They point out however, that only a very modest contribution from the field of ergonomics was identified in a review of the safety culture literature.

Generally, the physical disorders referred to in the National Institute of Occupational Safety and Health (NIOSH)'s proposed National Strategy for the Prevention of Work Related Psychological Disorders (Sauter et al., 1990), that "arise from poor ergonomic conditions" are primarily MSIs. Psychological health issues are not linked directly to cognitive or organizational ergonomics applications, rather they are strictly linked to the improvement of physical demands and characteristics of a job, i.e. MSI control, or physical ergonomics. The proposed strategy separates ergonomics from the

psychosocial issues, which are under consideration, and even suggests that safety assessments by Industrial Hygienists assessment should be expanded "to incorporate workplace risk factors for psychological disorders" (Sauter et al., 1990, p. 1153). Ergonomists are not included in this scenario. Curiously however, this same NIOSH document recommends that the HFES improve their focus on dissemination of knowledge on the topic of work and mental health. The collective messages over the years and recently from various occupational groups (e.g. OHS, OHP, HR, IH) do not present a strong message about ergonomics as being an area related to psychosocial hazard control, except through its relationship with MSIs.

Some occupations may focus on psychosocial hazards from the perspective of how they affect MSIs in the workplace, while other occupations with a very strong psychology background might see MSIs primarily in light of how they affect psychological health and their relationship with psychosocial hazards in the workplace. Ergonomists, on the other hand, may be best suited to see both directions of the relationship, or at least to see how Ergonomics can be used to address either hazard separately as well as together.

A downfall to the perception of ergonomics as being predominantly a health and safety matter is the oversight by business schools and professionals of the business-related benefits of ergonomics, who will therefore not benefit from ergonomics fully. Birchall (1975) implied that Ergonomists have handled the physical well enough, and that

everyone else (those involved in job design like industrial engineers or O&M specialists) must now look at the organizational social and personal aspects of jobs.

If managers understood the business benefits of ergonomics and its direct contribution to companies' strategies, ergonomics would be more accepted and better integrated into organizational processes and policies (Dul & Neumann, 2009). It is particularly difficult to apply ergonomics to address more system-wide issues in a business such as design and organization, or purchasing when decision makers are ill informed or mis-informed about ergonomics (Dul et al., 2012a). A business ergonomics approach would likely give ergonomics greater systems-wide exposure, resulting in more direct access to an organization's design processes, organizational design and communication paths, thereby having a more direct effect on psychosocial hazards (Genaidy et al., 1999).

## 2.4 MSIs, psychosocial hazards and Ergonomics

### 2.4.1 MSIs

Anecdotally there appears to be a general lack of understanding amongst employers, employees, OHS enforcement and policy makers in North America regarding the full breadth and definition of the field of ergonomics. Instead, the field appears to be more narrowly recognized as, and associated with, musculoskeletal injury (MSI) prevention, either in office settings or where manual handling tasks are required by work. Given the costs involved in dealing with MSIs in workplaces or amongst an ageing population, it is not surprising that when a field is associated with the prevention of these

types of injuries, that association could overshadow any other uses and benefits that field might have to offer.

In North America, Musculoskeletal Injury (MSI) related concerns seem to have been centered primarily around the costly and high incidence of Carpal Tunnel Syndrome and other repetitive strain or overuse injuries in the workplace, as well as around back injuries and chronic muscular pain. In 2010, the average number of days away from work for each claim of Carpal Tunnel Syndrome in the United States was 32, matched only by injuries involving fractures and amputations (Bureau of Labor Statistics (BLS) 2015). In 2014, the incidence rate (the number of injuries and illnesses per 10000 workers) in the United States for musculoskeletal disorders was 33.8. It had the highest incidence rate of all of the types of "non-fatal occupational injuries and illnesses involving days off work" reported in the USA in 2014 (BLS, 2015). McGee, Bevan and Quadrello (2011) note in their report for the Conference Board of Canada, that based on frequencies of MSI in the Canadian population in 1998 (and using 2005 prices), MSIs cost Canada over $20.6 billion.

In the province of Newfoundland and Labrador, the average yearly cost of MSIs (also referred to as "Soft Tissue Injuries") to WorkplaceNL (formerly the Workplace, Health, Safety and Compensation Commission (WHSCC)) is $86 M ("Musculoskeletal Injury (MSI) Prevention", n.d.). This is a cost that is carried by the employers of the province through their WorkplaceNL assessments (yearly fees which businesses are required to pay to WorkplaceNL, based largely on their history of claims and claims

costs.). On average in Newfoundland Labrador, MSIs account for 70% of all claims involving lost time from work ("Musculoskeletal Injury (MSI) Prevention", n.d).

Workers in all types of industries are susceptible to MSIs. In the United States, the occupations that experienced the highest incidence rate of MSIs in 2014 were nursing assistants, labourers, and freight/stock/material handlers (BLS, 2015). "Industry Fact Sheets" which WorkplaceNL makes available on their website show how individual industries in the province experience MSIs, when compared to one another and to the provincial average lost time claim incidence rate. Each major industry identified in these Industry Fact Sheets experienced MSI related claims. Only five out of a total of twelve industries were able to demonstrate a lower-than-provincial average number of MSI claims for more than one year out of five ("Industry Fact Sheets", 2014). Figure 4 shows the relative MSI experience of industries in Newfoundland and Labrador compared to the provincial average. The industries that consistently experience the higher than provincial average MSI incidence rates are manufacturing, fish processing and healthcare. (Only Finance/Insurance/Real Estate, Mining and Service sectors had consistently lower than provincial average MSI incidence rate between 2010 and 2014). No industry is without MSIs.

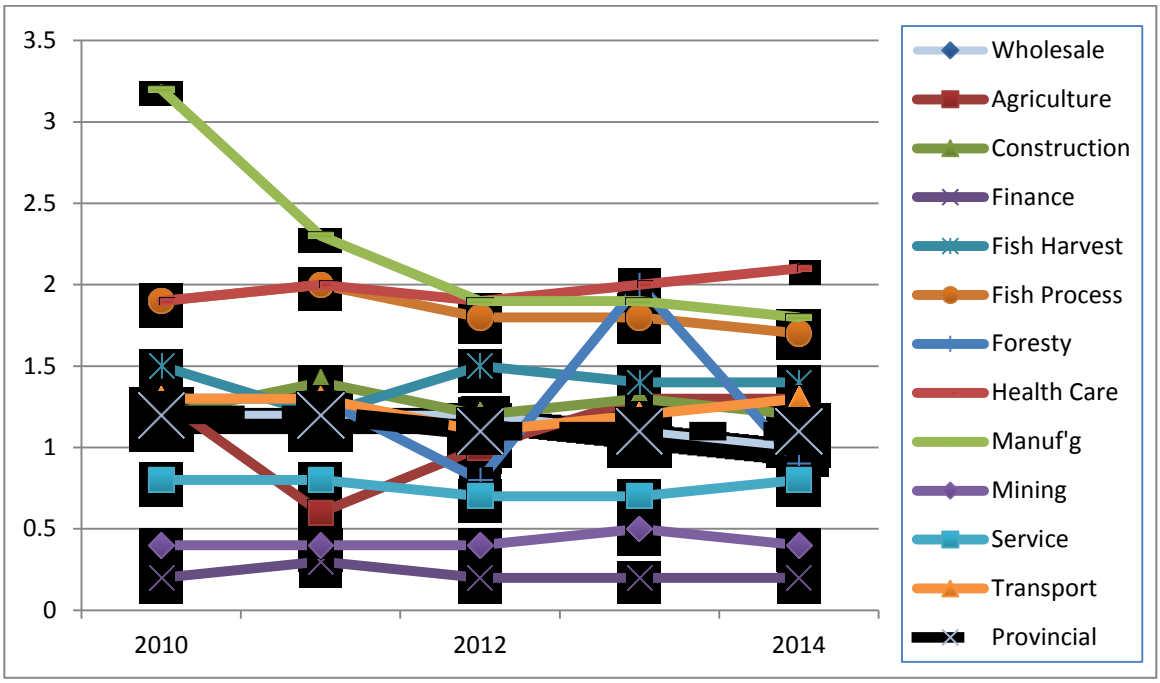


**Figure 4: Industry sector MSI claims experience in Newfoundland Labrador compared to the provincial MSI claims experience for 2010 – 2014 (WorkplaceNL, Industry Fact Sheets, 2014)**

From a business and economics perspective, it is logical that employers would be very interested in reducing the number of MSIs that occur at workplaces, and subsequently in minimizing their effects. If ergonomics is presented to them as the field to turn to in order to do so, it is not surprising that the common association made with ergonomics would be MSI prevention.

### 2.4.2 Psychosocial hazards

One of the most influential attributes of work, to the mental health of a worker, has been found to be the opportunities that work offers (or does not offer) the worker to be able to have their skills, knowledge and abilities used, resulting in the associated feelings of interest, sense of accomplishment, personal growth and self respect

(Kornhauser, 1965). However since the beginning of the 20th Century popular literature has depicted office life, and the effects of bureaucracy on its workers as being destructive (Merill, 1987). In his assessment of the organization as a structure, Glass (1975) describes bureaucracy as being "committed to process, procedure and obedience" and that it "literally feeds itself by objectifying its membership, [employees] reinforcing that objectification function" (p. 382). Mental health in the workplace was not necessarily the focus of Occupational Health and Safety at that time.

Mental health is defined as being a state of well-being in which the individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his own community (Gilbert & Blisker, 2012). In 2011 an estimated 21.4% of the working population of Canada experienced a mental illness. Furthermore it is estimated that the annual productivity impact of mental illness was approximately $6.4B in 2011 (Gilbert & Blisker, 2012). Productivity losses in this case were measured in time off from work (absenteeism) as well as hours at work with limited productivity (presenteeism) amongst other indicators, and the Gilbert and Blisker, (2012) concluded that "improved management of mental health in the workplace including prevention, early action to combat stress and identification of problems could decrease losses to productivity significantly" (p. 2).

In 1980 NIOSH identified occupational stress as being one of the primary factors that potentially compromise the well-being of employees (Christie and Barling, 2011). It

contributes to headaches, stomach problems, sleep disorders, irritability, loss of concentration as well as many other physical and psychological problems (Cahill, 1996). In 2014/15, stress accounted for 35% of all work related ill health cases and 43% of all working days lost due to ill health in the UK (Health and Safety Executive, 2015). European data indicated that work-related stress costs the EU at least 20 billion euros per year in lost time and health bills (Leka & Kortum, 2008). In 2007 the total cost of work-related mental stress to the Australian economy was $14.81 billion; the direct cost to employers alone in stress-related presenteeism and absenteeism was $10.11 billion (Safe Work Australia, 2013). Work related stress is clearly very common, and it has a high cost in terms of workers' health, absenteeism and lower performance. Workplace psychosocial hazards have been identified in the literature and research as being one of the contributors, amongst a number of others (e.g. financial concerns, work-life balance) to work related stress.

The International Labour Organization (ILO) and the World Health Organization's (WHO) joint committee on Occupational Health define psychosocial hazards in terms of the interactions among the elements of work, (work organization and design, working conditions and labour relations) versus employees' competencies and needs. "A negative interaction between occupational conditions and human factors may lead to emotional disturbances, behavioural problems, and biochemical and neurohormonal changes, presenting added risks of mental and physical illness" (ILO, 1986, p.4). Another, simpler definition, is that a psychosocial hazard is a "workplace factor that has the potential to cause psychological or physical harm if not adequately

eliminated or controlled" (Mental Injury Tool Group (MIT), 2012, p. 15). Specific work environment factors include excessive workloads, rotating shifts, role ambiguity, job insecurity and monotonous or repetitive tasks (Sauter et al., 1998; Sauter et al., 1990). Therefore design and management of work, and its social and organizational contexts can have the potential to help prevent psychological or physical harm (Cox & Griffiths, 2005).

The emphasis on identifying and controlling psychosocial hazards in the workplace has become stronger in the overall assessment of worker health and wellbeing (Bongers, Ijmker, Van & Blatter, 2006; Cahill, 1996; Elfering, Grebner, Gerber & Semmer, 2008; Leka & Kortum, 2008; Rick & Briner, 2000; Wiegand, 2012). Tabanelli et al. (2008) found that there was a proliferation of new questionnaires produced since the 1980s, designed to measure and evaluate work related psychosocial factors, indicating the growth in the attempts to quantify and therefore understand and deal with, work related stress.

Empirical evidence that psychosocial risk factors correlate with employee health outcomes has influenced regulatory bodies and multinational organizations to recognize the important effect of psychosocial risk factors on employee health and wellbeing, as well as productivity (Dollard et al., 2012). Some workplace factors related to psychological health are job content, workload and work pace, work schedules, control, environment and equipment, and organizational culture and function (Leka & Jain, 2010). In Canada, the recognition of psychological health at work has led to a number of initiatives, including the development of “Guarding Minds @ Work” (GM@W) through

the Centre for Applied Research in Mental Health and Addiction within the Faculty of Health Sciences at Simon Fraser University. The objective is to provide resources to promote psychological health and safety in the workplace. Thirteen Psychosocial Factors (PF1 – PF13) relevant to Canadian organizations and employees were assessed and listed (Samra, Gilbert, Shain and Blisker, 2012). A number of those psychosocial factors recognized by GM@W can be directly affected through the implementation of ergonomics. For an explanation of each factor as per GM@W, see Appendix D. According to the MHCC, the practice of designing or re-designing jobs using a psychological health and safety lens, has immense potential to reduce the risk of psychological injury (Gilbert & Blisker, 2012).

The Centre for Mental Health in the Workplace suggests that organizations that implement systems to safeguard the psychological health of their employees serve their business and service efficiency needs, and simultaneously protect psychological health and safety at work (Shain, n.d.). Where organizations and work system designs do not accommodate changing worker values, the expected result is deterioration of organizational efficiency and quality of performance (Argyris, 1971 as cited in Hendrick 2002). Implementation of ergonomics principles "in the design of operations can improve productivity, quality, technology implementation, and have intangible benefits for operations while also securing well being and working conditions for employees" (Neumann & Dul, 2010, p. 939). Given the objectives of ergonomics as a field, to optimize overall system performance and human well being, a relationship between ergonomics and psychosocial hazard control is clear.

### 2.4.3 The relation between ergonomics and psychosocial hazards

Job design characteristics have a significant effect on job stress, and therefore on psychological health and safety. In other words, they can become psychosocial hazards if they are inappropriately matched to the limitations and capabilities of workers. Work scheduling, workload, perceived fairness, concentration requirements and accommodation, self-management opportunities and problem solving requirements can each have an effect on job stress (Gilbert & Blisker, 2012).

Early research served to establish the importance of job design to psychological well being, "It confirmed the intuitively accepted view that simplified jobs were dissatisfying, and it introduced mental ill health as a potential consequence of exposure to such work" (Parker & Wall, 1998, p. 7). The job designer has an important role to play in an organization, ensuring that job design itself specifies contents, methods and task relationships to satisfy several organizational requirements (i.e. technological, functional and operational) and human requirements of the worker (i.e. physiological, physical, social and personal requirements) (David Birchall, 1975, p. 30). The objectives of task and job design are to design tasks which are effective, feasible and not harmful, and jobs which are satisfying, productive and in line with the objectives of the organization.

Job design has been recognized as one of several accepted approaches used to improve working conditions, thereby preventing work related psychological disorders. "Psychological problems secondary to the physical disorders that arise from poor ergonomic conditions are increasingly apparent" (Sauter et al., 1990, p. 1150).

Ergonomics can help with control of psychosocial hazards by optimizing job design, organizational systems, work expectations, role clarification (communication feedback systems) and so on. Topics which are relevant to the domains of specialization of ergonomics as outlined by the IEA include mental workload, decision-making, skilled performance, work stress, training, communication, crew resource management, work design, design of working times, teamwork, participatory design, new work paradigms, and quality management ("Definitions and Domains of Ergonomics", n.d. b)

Sociotechnical systems, the systems studied in a macroergonomics approach, include aspects of the workforce (such as human values, adaptation roles, capacities, limitations and problem solving abilities) (Carayon et al, 2015) that are linked to psychological health and wellbeing. A sociotechnical system is comprised of two related sub systems; the technology sub-system and the social sub-system. Technology sub-systems include equipment, machines, tools technology and work organization and social sub-systems include individuals, teams and the needs for coordination, control and boundary management (Mumford, 2006). There is a clear relationship here, of how the sociotechnical systems approach of macroergonomics can have a positive effect on the control of psychosocial hazards, by directly affecting psychosocial factors in the workplace.

A number of PFs (psychosocial factors contributing to good mental health at work) identified by GM@W (2012) can be improved by the systems approach and application of ergonomics principles as described in ISO 26800: 2011 Ergonomics:

General Approach, Principles and Concepts (2011) and ISO 6385: 2004 Ergonomic principles in the design of work systems (2004). For a list of the principles cited in each of these two Standards, see Appendix E. PF13, "protection of physical safety", is described as "a work environment where management takes appropriate action to protect the physical safety of employers" (Gilbert et at., 2012). From an ergonomics perspective, this is traditionally directed to physical ergonomics applications (i.e. prevention of MSIs). There are other PFs however, for which the use of cognitive and organizational ergonomics would be effective without the direct need to protect musculoskeletal health, such as PF3 (Clear Leadership & Expectations), PF5 (Psychological competencies and requirements, PF8 (Involvement and Influence), and PF9 (Workload management). Table 1 illustrates the relationship that effective use of ergonomics has with the control of workplace psychosocial hazards, by showing how the topics related to ergonomics relate to each of the above PFs.

Table 1
Comparing workplace psychosocial factors with topics affected by ergonomics

| **Psychosocial Factors as per GM@W** | **Topics affected by ergonomics, as per IEA definition** |
|---|---|
| PF3: Clear leadership and expectations | Decision making, work stress, training, communication, teamwork, participatory design, new work paradigms, quality management |
| PF5: Psychological competencies and requirements | Mental workload, skilled performance, work stress, training, work design, design of working times, teamwork, new work paradigms, quality management |
| PF8: Involvement and influence | Decision making, work stress, communication, design of working times, teamwork, participatory design, quality management |
| PF9: Workload Management | Mental workload, skilled performance, work stress, training, communication, crew resource management, work design, design of working times, teamwork, new work paradigms, quality management |
| PF13: Physical Safety | Skilled performance, work stress, training, crew resource management, work design, design of working times, teamwork |

## 2.5 PC and OC and peer reviewed journals ("employer support")

Studying the OC and PC of EPs provides the profession with insight about how EPs relate to the profession and to their employers. This information can be used to benefit employers of EPs and EPs themselves, to help them engage in their work and their organization, and by assisting them to enrich their experience in the field. Employee Commitment can have an effect on how employees spend their time at work, the quality of their work, morale, organizational citizenship behaviour and ultimately the success of their organization (Giffords, 2009; Lee, et al., 2000; Shore & Wayne, 1993; Meyer, Allen, & Topolnytsky, 1998; Seruya & Hinojosa, 2010). Committed individuals believe in and accept organizational goals and values, so they want to remain with the organization and commit themselves to providing quality services on behalf of the organization (Chen 2007). If EPs experience low levels of OC and PC, they may not be satisfied enough to want to continue to invest their time and efforts into the organization, or perhaps into the profession itself.

Organizational commitment (OC) is a psychological state that (a) characterizes the employee's relationship with the organization, and (b) has implications for the decision to continue or discontinue membership in the organization (Meyer & Allen, 1991). Similarly, Professional Commitment (PC) is a psychological state such as OC, but which pertains to the profession itself as opposed to an organization. Either type of commitment can be seen as the strength of an individual's identification with and involvement in the goals and values of a profession (Aranya, Pollock & Amernic, 1981). OC can be tested separately from CP, and these two constructs may have an effect on one another,

depending on the profession and the nature of the organization in question (Meyer, Allen & Smith, 1993).

OC and PC are reflections of the level of acceptance of organizational and professional values respectively, willingness to exert effort, and the desire to maintain membership in the organization or profession (Aranya et al., 1981; Mowday, Steers and Porter, 1979) and they are comprised of three types of commitment; (affective, normative and continuance), collectively referred to as comprising the Three Component Conceptualization Model (TCM) (Meyer & Allen, 1991). Affective Commitment is an employee's emotional attachment to, identification with, and involvement in the organization (OC). Someone with a strong PC Affective Commitment might be more likely than others to subscribe to trade journals or attend conferences and so on. Normative Commitment is a feeling of obligation to continue employment (OC), and this type of commitment may also result in increased professional activities (PC). Continuance Commitment is an awareness of the costs associated with leaving the organization (OC) or a profession (PC), and there might be less of an inclination to be involved in voluntary professional development activities. Employees with a strong Continuance Commitment to a profession (PC) may be less likely to engage in promotion of the profession to the public or in compliance with professional best practices and standards (Meyer et al., 1993). Clearly there is an advantage to an employer to have employees who demonstrate affective or even Normative Commitment over Continuance Commitment.

The TCM has established itself as the dominant approach in North America, to identification of OC and PC (Cohen, 2007; Hassan, 2012) and Meyer et al. (1993) reported in their test of the TCM for commitment measurement, that the occupational scales which they developed can be easily used for other occupations or professions by modifying descriptors as needed. Meyer et al. (1993) also showed in their test of the TCM for OC that the test could be expanded to test for PC as well, and that "the constructs of affective, continuance and normative commitment appear to be generalizable across domains" (p.550). This view was supported by Snape and Redman (2003) in their evaluation of the TCM amongst the UK's Human Resources Management specialists and by Bagraim (2003) in a study of PC amongst South African actuaries.

For the purposes of this study, "employer support" is defined as providing EPs with access to peer reviewed journals and professional development events. There is a very large body of literature that has shown the relation between MSIs and psychosocial hazards, and much of it appears to be published in the ergonomics journals in the EJL 2005, such as *The Journal of Occupational and Environmental Hygiene*, (Johnston, Ladsittel, Nelson, Gardner & Wassell, 2003; Reme et al., 2014), *American Journal of Industrial Medicine* (Brown et al., 2011; Huang, Feuerstein, Kop, Schor & Arroyo, 2003; Torp, Riise & Moen, 2001) or the *Scandinavian Journal of Work Environment and Health*, (Bongers, De Winter, Kompier & Hildebrandt,1993; Hannan, Monteilh, Gerr, Kleinbaum & Marcus, 2005; Joling, Blatter, Ybema & Bongers, 2008; Kompier & van der Beek, 2008).

This research however, is also present in other journals, not clearly related to ergonomics such as *Occupational Rehabilitation*, (Bongers et al. 2006), *Occupational Environmental Medicine,* (Driessen et al., 2011; Vandergrift, Gold, Hanlon & Punnet, 2012) *American Journal of Public Health* (Kerr et al, 2001), *Social Science & Medicine,* (Lang, Ochsmann, Kraus & Lang, 2012), *Occupational Medicine*, (Leroux, Brisson & Montreuil, 2006) and *Biomedical Research International* (Thiese et al., 2015).

This is relevant because journals, to which an employer provides access, may not necessarily have to be an ergonomics journal to be helpful. If EPs work in organizations where there is difficulty obtaining the funding for access to more than one journal, then the choice of journal may need to reflect a topic which is of interest to a number of types of employees, which may require it to be a journal that is from a field that is outside of (but related) to ergonomics. Using impact factors from 2008 and 2009 Buckle (2011) clearly illustrated how amongst psychology journals, industrial engineering journals and public health/medicine/epidemiology journals, *Ergonomics* (the top journal of the EJL 2005) is ranked 50$^{th}$, 10$^{th}$ and 100$^{th}$ respectively. Similarly, the Australian Business Dean Council quality journal list, which is used to rank journals in all business schools in Australia, excludes any ergonomics journals (Thatcher & Yeow, 2015). If more than one journal can be accessed, then ergonomics journals might be well complimented by access to highly ranked journals from other fields as well, to round out the perspectives and the "awareness" of EPs as much as possible.

## 2.10 Regulations

In some countries, the field of Occupational Health and Safety (OHS) considers psychosocial hazards in the workplace to be one of the many workplace hazards that must be managed, as a part of worker well being. This is evident in the OHS legislation of several countries, such as Australia, the U.S. and amongst countries in the EU, where OHS legislation has been interpreted as including the management and control of psychosocial hazards.

The South Australia Government's Work Health and Safety Act, (2012) defines "health" as being inclusive of physical and psychological health (Part 1; Division 3; Subdivision 1). In the U.S., NIOSH is authorized through the research sections of the OHS Act to include psychological factors among the health and safety issues to be researched (Cohen and Margolis, 1973). Austria, Denmark, Estonia, Finland, France, Greece, Slovakia and Sweden highlight in their legislation the need to take psychosocial risks or mental health into consideration when dealing with OSH, and Belgium, Bulgaria, Cyprus, Germany, Hungary, Italy, Latvia, Lithuania, Portugal and the United Kingdom specifically include the obligation to do a psychosocial risk assessment (Eurofound and EU-OSHA, 2014). For example, the UK's *Health and Safety at Work etc. Act,* 1974, do not differentiate between physical and psychological injury (Rick & Briner, 2000, p. 310).

Across Canada provincial and federal jurisdictions continue to add to, and improve upon, existing OHS laws and regulations where MSI prevention is concerned (ACE, 2011).

Regulations, which are in fact MSI prevention regulations, are often referred to as being "ergonomics" regulations, even though regulating ergonomics is not the intent. The intent is to prevent MSI hazards from occurring in workplaces. Most of these use basic OHS principles to do this, as well as some "physical" ergonomics applications. The appetite to create and enforce this type of legislation is likely the product of the financial and productivity costs of MSIs to workers, businesses and to society.

Given that such a strong relationship has been established between psychosocial hazards and the onset of MSIs, perhaps OHS Regulations enforcing psychosocial hazard prevention (through the use of cognitive and organizational ergonomics among other things) could have a more positive effect on the reduction of MSIs than the traditional singular (physical) approach has had to date. The various legal requirements for provision of psychologically healthy and safe workplaces include Occupational Health and Safety law, unemployment contract law, labour law, tort law, human rights, workers' compensation statutes and employment standards legislation (Shain, 2010). In 2010 most of these were in the early stages of recognizing that psychologically safe workplaces must be a requirement, (with a major focus at the time on harassment and violence in the workplace) and how that could be achieved. OHS laws in Alberta do not specifically identify psychosocial hazards, however the need to provide a safe and healthy workplace is being interpreted by the Alberta government as including psychological health and safety (Government of Alberta, 2011).

In 2013 the Canadian Standards Association introduced a new standard, Z1003;

Psychological health and Safety in the workplace – Prevention, promotion and guidance to staged implementation. CSA Standards are not by definition law, however regulators and policy makers can chose to adopt any Standard in such a manner to be enforced like other aspects of the Act or Regulation it has been adopted into. Z1003 has not been adopted into OHS regulation in Canada at this time. It does, however, provide a (voluntary) starting place for businesses to understand how to implement psychosocial hazard control in the workplace.

An opportunity for regulators to adopt psychological workplace safety enforcement practices currently exists in that it may be appropriate to expand on the current "ergonomics-related" regulations in order to begin to address psychosocial hazards in Canadian workplaces. If regulators and policy makers were aware of the practical relation between ergonomics and psychosocial hazard controls in the workplace, (i.e. aware of the breadth of the field of ergonomics) this could possibly be achieved since an infrastructure of practices already exists in Canadian legal domains for regulating MSI prevention as well. This could be an easier environment in which to implement change than that of the original (first) MSI regulations when they were introduced in B.C. in the 1980s (personal communication, B. Saravanabawan, 2008).

Figure 5 illustrates the steps that an issue may go through during its "gestation" through from early recognition before it is at the point of being addressed by policy makers. Ergonomics itself went through this process, and psychological health (and the control of psychosocial hazards) appears to be no different. With the past focus, research,

discussion, literature and conferences surrounding the issue of psychological safety and workplace psychosocial hazards, and the recent CSA Standard being published, it would appear that the issue is currently at the "public domain" stage. The next step would then be expected to be "Government Regulations" (and indeed has been at that stage in some countries already, ahead of others). The danger is that if there is a lower than desired level of "awareness" in the ergonomics community, it doesn't provide the clear and practical feedback and information needed at this step of Issue Gestation, to ensure that ergonomics is recognized for all that it can offer, if and when regulations are considered for addressing psychological health and safety in the workplace.

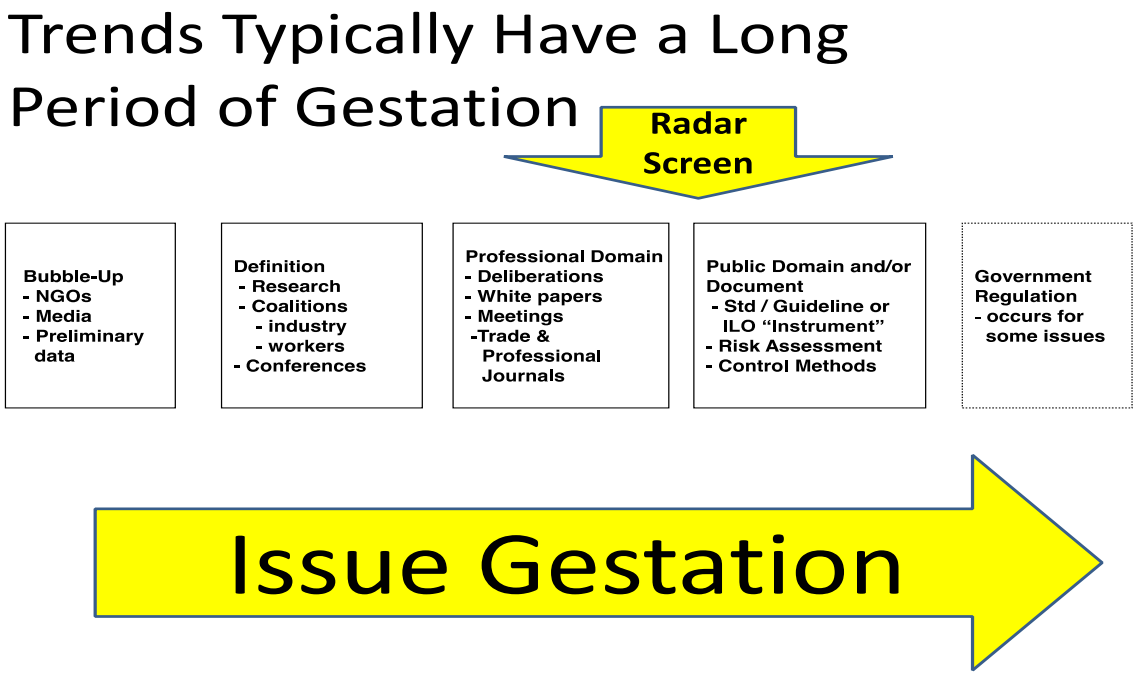


**Figure 5 Taubitz, 2012 Steps followed by trends to Government Regulations**

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Methods and objectives

The purpose of this study is to explore the current level of awareness that EPs have of the relation between ergonomics and workplace psychosocial hazard control (independently of MSI prevention). The objective is also to identify possible variables that could influence (or be influenced by) that awareness, specifically Occupational or Professional Commitment, and employer support. The study used an electronic survey that was distributed to professional associations representing the occupations of EP in Canada and the U.S. to gather information from EPs about their perspectives on the breadth of ergonomics, their employment conditions and on their tendency to demonstrate either OC or PC or both. This chapter describes the design of the electronic survey used to gather information, the possible variables of interest and their analysis for this study.

### 3.1.1 Study population

For the purpose of this study, EPs were defined as professionals who are likely to practice ergonomics as a part of their vocational workload. EPs were asked to participate in an electronic survey to share their perspective on ergonomics, particularly with regard to its use in controlling workplace psychosocial hazards.

All surveys were submitted electronically to professional associations representing the EP occupations. Some groups posted the invitation on their member-only website, or on their LinkedIn pages or sent the invitation by email to their membership. See Appendix B for further detail on how each group distributed the survey.

The professional groups amongst the EPs (referred to in the analysis of the research as "occupations") included in the distribution of the survey were:

- Ergonomics and Human Factors
- Industrial Hygiene
- Occupational Health and Safety
- Kinesiology
- Occupational Therapy
- Physiotherapy
- Industrial Engineering
- Occupational Health Psychology

The number of responses generated from participation through each professional association is not clear, since responses were received from individuals directly and not from the associations. Estimated response numbers through associations are listed in Table 2 (based on the occupation with which respondents self-identified) to show an approximate distribution of responses. With the exception of Occupational Health Psychology, there was at least one response from each group. The majority of responses came from individuals who self-identify as either an Ergonomist or a Human Factors specialist.

Table 2
Possible exposure to participants, and number of responses received

| Professional Association | Dissemination method | Exposure estimate | Estimated completed surveys |
|---|---|---|---|
| **Association of Canadian Ergonomists (ACE)** | Association email to individual members. | 700 members | 72 |
| **Canadian Physiotherapy Association (CPA)** | e-newsletter, "The National Rounds" | 14000 subscribers | 14 |
| **Canadian Occupational Therapy Association (CAOT)** | e-newsletter, "OT Weekly", | 8000 subscribers | 12 |
| **Institute of Industrial Engineers (IIE) (Toronto and Atlantic Canada Chapters)** | Email to Toronto and Atlantic Canada Chapter chairs. | 110 members | 1 |
| **Ontario Kinesiology Association (OKA)** | e-newsletter, "e-Kinnection" | 1200 subscribers | 11 |
| **British Colombia Association of Kinesiologists (BCAK)** | Newsfeed on the website * | 600 members | 4 |
| **Canadian Society of Safety Engineering (CSSE)** | LinkedIn* CSSE site | 8000 followers | 23 |
| **Board of Canadian Registered Safety Professionals (BCRSP)** | LinkedIn* BCRSP site | 4785 | 3 |
| **American Association of Industrial Hygienists (AIHA) Atlantic Canada chapter** | Chapter email to individual members | 80 | 3 |
| **Society for Occupational Health Psychology (SOHP)** | LinkedIn* SOHP site | 193 followers | 0 |
| | **Total:** | 37668 | 143 |

*Note.* Estimates for number of respondents from each category are made based on the professional affiliation claimed by each survey participant. Since some participants (21) are members of more than one of these professional associations, more surveys are accounted for than were submitted. True origin of each participant's access to the survey cannot be traced.
* This is a website page with public access

In total 192 responses were received, however 70 respondents dropped out of the survey. Of the remaining 122 respondents, 25 confirmed that their ergonomics work comprises less than ¼ of their full work volume, which was a programmed trigger for the survey to end. Of the remaining 97 respondents two more surveys were eliminated because they had not fully completed the survey. Of the remaining 95 respondents, 94 responded to questions regarding employer support, 79 responded to questions regarding the relation between ergonomics and psychosocial hazards control and a total of 77 respondents completed the entire survey including questions regarding Organizational and Professional Commitment.

### 3.1.2 Survey design

The study used a survey to gather information from EPs (see Appendix A for the full survey), which was programmed using the Qualtrics computer survey system for research. Once professional associations had posted the invitation and the link to the survey on their chosen web applications, individual participants could fill in the survey. The results were compiled in the Qualtrics software program and were anonymous. There were no monetary or other incentives offered for participation. The survey was open for responses from May 2015 to August 2015, with no follow up reminder sent out to the associations to repost.

The survey consisted of five parts. Part I solicited demographic information including important questions about which occupation the participants identified with most and whether any certification or licensure had been obtained. Part II consisted of six

questions about the volume of work being performed in ergonomics, as well as the years of experience in the field and the type of setting in which the respondents work. Part III posed four questions regarding employer support and access to professional development and peer-reviewed journals. Part IV was designed to elicit opinions from the participants on psychosocial hazards in the workplace, and their relation to ergonomics. Finally, Part V consisted of questions that are designed to identify a degree of OC and PC amongst respondents.

The survey was pilot tested with a group of representatives from three of the EP occupation groups. The groups represented were "Ergonomist", "Occupational Health and Safety professional" and "Occupational Therapist" and their feedback was incorporated into the design of the survey. These outcomes are not reported in this thesis.

## 3.2 Variables

Variables that were included in the study's final analyses are outlined below, describing how they were developed from the survey questions and responses. There was some information obtained for variables that might have been interesting to test as well, however were not included in the final analyses.

### 3.2.1 Tested variables

**Occupations (PEs)**

This variable is referred to in the analysis as Occupations. Participants were asked to choose from a list of occupations (as listed in 3.1.1 Study Population) to show which

occupation they most identify themselves with. Since sample groups were very small when divided out amongst occupations, groups were made for analysis purposes. In order to group Occupations with similar professions, four categories were developed. Ergonomists/Human Factors specialists made one Occupation group (A), Occupational Therapists, Kinesiologists and Physiotherapists made up the second Occupation group (B) and Safety professionals were an independent Occupation group (C). Industrial Hygienists had a very small sample size, however given the noticeable difference between their possible work settings and educational background compared to the other Occupations, they were identified as an individual group (D). These groups then become the foundation for the analysis of hypothesis #1.

**Volume of work**

The survey asked if a participant's ergonomics portion of their work accounted for more or less than 25% of their regular duties (full or part time), and the survey was programmed to end if the participant indicated that their ergonomics volume was less than 25% of their regular duties. This was a "yes", "no" answer. The remaining participants were asked to identify their range of volume of ergonomics work. Ranges used were less than 50%, 50% - 75% and >75% - 100%.

**Years of experience**

Years of experience were identified by ranges; "less than 5 years", "5-10 years", "11 – 15 years" and ">15 years"; participants indicated which range accurately depicted the number of years of experience in ergonomics they had.

**Awareness**

"Awareness" was defined as a respondent's understanding that ergonomics can be used to control psychosocial hazards in the workplace, independently of the MSI prevention target. This variable is referred to in the analysis as "awareness". In order to establish confidence that the participants understood the nature of the inquiry, a question regarding the participants' awareness of the breadth of ergonomics was posed more than once, each time using a different approach. Two questions (4.5 and 4.6) required a simple "yes/no" or "I don't know" answer, whereas three questions, (4.7 – 4.9) required a response to a 5-point Likert-like scale. As a result, "awareness" was measured in three ways: numeric (using questions 4.7 – 4.9), 3-category (using questions 4.5 and 4.6) and a combination of all five of the questions (by combining numeric and 3-category into 4 categories).

**Employer support**

Part III of the survey was aimed at establishing whether the respondents have access to peer-reviewed journals and to professional development opportunities, particularly if these are supported by their employers. This variable is referred to in the analysis as "Support". It helped to establish a level of employer support (in the context of the journal and professional development access), and was relevant for analysis of hypothesis #3. Questions 53 (*Does your employer support access to professional or peer reviewed journals?)* and 54 (*"Does your employer support your continued professional development?")* were used. Answer choices were "yes" and "no".

**Organizational and Professional Commitment**

Questions in Part V of the survey measured a participant's tendency towards either OC or PC using a 36-item scale developed by Meyer, Allen and& Smith (1993); the Three Component Model (TCM) scale. Three forms of employee commitment to the organization and to the profession are measured with this model: affective commitment (desire based), normative commitment (obligation based), and continuance commitment (continuance based). Item responses are made on a 7-point Likert-type scale where 1 = strongly disagree and 7 = strongly agree.

The TCM uses three scales: the Affective Commitment Scale (ACS), the Normative Commitment Scale (NCS), and the Continuance Commitment Scale (CCS). Abston (2015) described the ACS ($\alpha = .82$), NCS ($\alpha = .83$), and CCS ($\alpha = .74$) as having been shown to have consistent reliability estimates (Cronbach's alphas) and that predictive, discriminant, and convergent validity were at acceptable levels.

### 3.2.2 Extra variables not tested in the final analyses

The following variables had been included as questions on the survey, as they were considered at the time to be important to the analysis of the hypotheses. These variables however, were not included in the analysis for separate reasons, as outlined below.

**Nature of employment**

The nature of employment was asked in the survey (i.e. self employed, government, private) because it was thought that this information may be needed to further investigate the nature of the OC and PC. In the same vein, the information regarding the work setting was gathered. This consisted of finding out whether the participant works in a setting where ergonomics services are the primary function of the organization, or if their work is to provide ergonomics services as a part of an organization that provides other services as a primary function (e.g. an EP providing ergonomics services for the workers in a retail setting). This information was not used in the analysis of the stated hypotheses, since the number of responses to this question made it a smaller sample size than desired.

**Psychosocial Hazards identification**

Participants were asked to agree or disagree using a 7-point Likert-like scale, with a statement on whether each of 20 conditions (identified by MIT (2012) as being psychosocial hazards) were important to the health and safety of workers. In case participants were inconsistent in their responses to the "awareness" questions, this "psychosocial hazards identification" variable could have assisted in revealing whether the participants were in fact able to identify psychosocial hazards. If they could not, this would likely result in their inconsistent responses to other questions. This was however not necessary since it was shown through analysis that two separate statistical measures of "awareness" were in agreement, indicating that participants were consistent in their

responses regarding the relationship between psychosocial hazard control and ergonomics (Section 4.2.1).

# CHAPTER 4: RESULTS

## 4.1 Descriptive Analysis

Table 3 presents the characteristics of the respondents and their work settings. Participants spanned the age ranges consistently (the youngest possible was 21 years of age) and the majority of respondents were female (66%, n=80), who self identified with the "Ergonomist" occupation (42%, n = 52) and are certified Ergonomists (34%, n = 42). They had more than 15 years of experience in ergonomics (46%, n= 44).

The second largest group of respondents identified themselves as OHS professionals (24%, n=20), had certification in OHS (21%, n= 27) and had 5 – 10 years of experience with ergonomics (21%, n= 20).

**Survey comments summary**

One of the most prevalent messages which came from the comments provided by participants, was that many of them were "aware", however were either not hired to perform outside of the MSI prevention area, or hadn't really thought about it before but were sure that psychosocial hazard control could benefit from ergonomics interventions. Several Ergonomists pointed out that even though they were "aware", they were unable to work in that area. Some EPs of all occupations mentioned that cognitive and organizational aspects are more a part of human factors than ergonomics. Some comments were made that MSI prevention and control is ergonomics, and that psychosocial hazard control is not the realm of ergonomics.

Table 3
Demographics of sample participants

| Demographics of Sample* | %(n) | Demographics of Sample** | %(n) |
|---|---|---|---|
| **Age Group** | | **Volume of work is Ergo.** | |
| less than 20 years | 0 | less than 50% | 36 (35) |
| 21-35 years | 30 (36) | 50% – 75% | 27 (26) |
| 36 – 50 years | 39 (47) | > 75% | 36 (35) |
| > 50 years | 32 (39) | **Years of Experience** | |
| **Gender** | | Less than 5 years | 18 (17) |
| Male | 34 (42) | 5 – 10 years | 21 (20) |
| Female | 66 (80) | 11 – 15 years | 15 (14) |
| **Occupation** | | > 15 years | 46 (44) |
| Ergonomist | 42 (52) | **Location of work** | |
| Human Factors specialist | 4(5) | Western (BC and AB) | 21 (20) |
| Occupational Health Psychologist | 0 | Central (MB, Sask) & Territories | 5 (5) |
| Occupational Therapist | 9 (11) | Quebec | 15 (14) |
| Physiotherapist | 9 (11) | Ontario | 42 (40) |
| Kinesiologist | 3 (4) | Atlantic | 13 (12) |
| Safety Professional | 20 (24) | Outside Canada | 4 (4) |
| Industrial Hygienist | 7 (8) | **Nature of Employment** | |
| Other Allied Health Professional | 6 (7) | Organization with ergo focus | 9 (9) |
| **License/Certification** | | Organization without ergo focus | 23 (22) |
| CCPE | 27 (33) | Government setting | 46 (44) |
| CPE | 7 (9) | Self employed | 17 (16) |
| Licensed OT | 11 (14) | Private organization (not self e.) | 33 (31) |
| Licensed PT | 13 (16) | **Employer supported journal access** | |
| Registered Kinesiologist | 13 (16) | Yes | 72 (68) |
| CRSP | 21 (26) | No | 30 (26) |
| CHSC | 0 (1) | **Uses peer reviewed journals** | |
| CIH or ROH | 3 (3) | Yes | 83 (78) |
| Other | 27 (33) | No | 17 (16) |
| No license or certification | 14 (17) | **Employer supported prof dev access** | |
| **Ergonomics is > .25 work vol.** | | Yes | 94 (88) |
| yes | 80 (97) | No | 6 (6) |
| no | 29 (25) | | |

*Note:* Percentage is rounded and may not add to 100% since some participants did not answer all questions or indicated more than one response.
*Sample size = 122 for all demographics in the left column.
**Sample size = 95 for all demographics in the right column with the exception of Volume of work where 96 participants provided information

The following are some of the Ergonomist's comments (since this Occupation had the most comments on the topics) regarding their perception of the relationship between ergonomics and psychosocial hazard control, independent of MSI prevention.

For question 4.5, "Do you believe that ergonomics can be applied in order to control psychosocial hazards in the workplace, independently of musculoskeletal injury prevention issues?":

"Mais toutefois, la porte d'entrée des ergonomes est souvent advantage reliée au physique" [*But usually the mode of entry for ergonomists is through the physical*] (paraphrased by author)

For question 4.6, "Do you believe that there is any research done in the ergonomics field on psychosocial hazards, which is independent of the issue of musculoskeletal injuries?":

"I think it [research] is being done but may not either call it ergonomics or the researcher will always relate it to MSD in some way, due to funding requirements for the research"

"mais la majorité des etudes est fait par d'autres disciplines"

[but the majority of the studies [on ergonomics and psychosocial hazards control] is done by other disciplines]

For question 4.7, “Ergonomics deals primarily with musculoskeletal injuries and how to prevent them.”:

“No, but that seems to be the consensus in Canada”

“Yes if you were talking about the mandate of my job. There is a much larger ergo worked out there though and preventing MSIs is just a piece of it.”

“This is what most employers feel and is where most money is put when ergonomics is put in place.”

“I don’t feel this statement is just much rooted in the general public’s understanding of ergonomics, or our profession’s understanding, but could be more rooted in how we do ergonomics (i.e. tied to OHS management, risk management, loss prevention) rather than design.”

“This is a widely held belief in the public arena; however, this is just one area of practice.”

## 4.2 Data Analysis

All statistical analyses were conducted using SPSS Statistics 17.0.

### 4.2.1 “Awareness” and EPs

Analysis to determine the most appropriate measure of “awareness” showed that there was agreement between numeric “awareness” and 3-category “awareness” and that

4-category is therefore an acceptable measure of "awareness". (See Appendix C for more detailed description of analysis of "awareness").

Kendall's tau-b and Spearman correlations were first calculated between the demographic variables and the two categorical "awareness" variables. These results were found to be consistent (in agreement) with results for numeric "awareness". Gender was not significantly correlated with either 3-category "awareness" (*Kendall's* $\tau_b$ = .051, $p$ = .639; *Spearman's* $\rho$ = .053, $p$ = .642), or with 4-category "awareness" (*Kendall's* $\tau_b$ = .007, $p$ = .945; *Spearman's* $\rho$ = .008, $p$ = .945). Age approached significant negative correlations with both 3-category "awareness" (*Kendall's* $\tau_b$ = -.156, $p$ = .131; *Spearman's* $\rho$ = -.172, $p$ = .129), and 4-category "awareness" (*Kendall's* $\tau_b$ = -.188, $p$ = .056; *Spearman's* $\rho$ = -.218, $p$ = .053). However, Age's correlation with "awareness" is dwarfed in significance by negative correlations between Years of Experience and both 3-category "awareness" (*Kendall's* $\tau_b$ = -.293, $p$ = .004; *Spearman's* $\rho$ = -.318, $p$ = .005), and 4-category "awareness" (*Kendall's* $\tau_b$ = -.365, $p < .001$; *Spearman's* $\rho$ = -.425, $p < .001$).

In the analyses that follow, the partial Spearman correlations between Occupation variables and categorical "awareness" variables control for the effect of Years of Experience as a demographic variable. Participants were categorized into one of four categories of occupation based upon their response to question 1.5 in the Survey "of the choices below, with what role do you most identify". Where necessary, responses to question 1.6 "Do you have a license or certification; please mark all that apply" were

considered as well. The resulting four categories were identified as outlined in Table 4, and are referred to as Occupation Groups A through D.

Table 4
Occupation Groups A through D

| | |
|---|---|
| Ergonomist/Human Factors Specialist | A |
| Occupational Therapist/Physiotherapist/Kinesiologist | B |
| Safety Professional | C |
| Industrial Hygienist | D |

All partial correlations are positive, indicating that movement from Occupation A through to Occupation D is associated with moving from a more "aware" to a less "aware" classification. The strongest association is found between 3-category "awareness" and the 2-category Occupation variable that groups (A) vs. (B, C, D). This is consistent with results from the numeric "awareness" analysis.

***3-category "awareness" correlated with 4-category Occupation:***

Prior to controlling for the Years of Experience, the Spearman correlation between 3-category "awareness" and 4-category Occupation is positive and significant ($\rho = .312$, $p = .005$); see Table 5. After controlling for Years of Experience, the resulting partial Spearman correlation is very slightly moderated in both effect size and significance (*Spearman partial* $\rho = .299$, $p = .008$) (see Table 6).

Table 5

3-category "awareness" correlated[a] with 4-category Occupation

| | | | Aware_3cat | Occup | YoExp |
|---|---|---|---|---|---|
| Spearman's rho | Aware_3cat | Correlation Coefficient | 1.000 | .312 | -.318 |
| | | Sig. (2-tailed) | . | .005 | .005 |
| | Occup | Correlation Coefficient | .312 | 1.000 | -.092 |
| | | Sig. (2-tailed) | .005 | . | .422 |
| | YoExp | Correlation Coefficient | -.318 | -.092 | 1.000 |
| | | Sig. (2-tailed) | .005 | .422 | . |

a. Listwise N = 78

Table 6

3- category "awareness" correlated with Occupation (controlled for Years of Experience)

| Control Variables | | | Aware_3cat | Occup |
|---|---|---|---|---|
| YoExp | Aware_3cat | Correlation | 1.000 | .299 |
| | | Significance (2-tailed) | . | .008 |
| | | Df | 0 | 75 |
| | Occup | Correlation | .299 | 1.000 |
| | | Significance (2-tailed) | .008 | . |
| | | df | 75 | 0 |

All subsequent investigations involving categorical "awareness" and categorical Occupation variables revealed a similar moderation of the effect size and significance

once controlled for Years of Experience. Hence, only the partial correlations (controlled for the demographic variable Years of Experience) are reported.

***4-category "awareness" correlated with 4-category Occupation:***

After controlling for Years of Experience, the resulting partial Spearman correlation between 4-category "awareness" and 4-category Occupation is positive and significant (*Spearman partial* $\rho = .265$, $p = .020$); Table 7.

***3-category "awareness" correlated with Occupation grouping A,B vs. C,D:***

After controlling for Years of Experience, the resulting partial Spearman correlation between 3-category "awareness" and the variable indicating Occupation group (A,B) vs. Occupation group (C,D) is positive and significant (*Spearman partial* $\rho = .256$, $p = .025$); see Table 8.

***4-category "awareness" correlated with Occupation grouping A,B vs. C,D:***

After controlling for Years of Experience (Table 9) the resulting partial Spearman correlation between 4-category "awareness" and the variable indicating Occupation group (A, B) vs. Occupation group (C, D) is positive and significant (*Spearman partial* $\rho = .223$, $p = .051$).

Table 7
4- category “awareness” correlated with 4 category Occupation (controlled for Years of Experience)

| Control Variables | | | Aware_4cat | Occup |
|---|---|---|---|---|
| YoExp | Aware_4cat | Correlation | 1.000 | .265 |
| | | Significance (2-tailed) | . | .020 |
| | | df | 0 | 75 |
| | Occup | Correlation | .265 | 1.000 |
| | | Significance (2-tailed) | .020 | . |
| | | df | 75 | 0 |

Table 8
3-category “awareness” correlated with Occupation grouping A,B vs. C,D:

| Control Variables | | | Aware_3cat | Occup2 |
|---|---|---|---|---|
| YoExp | Aware_3cat | Correlation | 1.000 | .256 |
| | | Significance (2-tailed) | . | .025 |
| | | df | 0 | 75 |
| | Occup2 | Correlation | .256 | 1.000 |
| | | Significance (2-tailed) | .025 | . |
| | | df | 75 | 0 |

Table 9
4-category “awareness” correlated with Occupation grouping A,B vs. C,D:

| Control Variables | | | Aware_4cat | Occup2 |
|---|---|---|---|---|
| YoExp | Aware_4cat | Correlation | 1.000 | .223 |
| | | Significance (2-tailed) | . | .051 |
| | | df | 0 | 75 |
| | Occup2 | Correlation | .223 | 1.000 |
| | | Significance (2-tailed) | .051 | . |
| | | df | 75 | 0 |

***3-category “awareness” correlated with Occupation grouping A vs. B,C,D:***

After controlling for Years of Experience, the resulting partial Spearman correlation between 3-category “awareness” and the variable indicating Occupation group A (Ergonomist or Human Factor Specialist) vs. Occupation group (B, C, D) is positive and significant (*Spearman partial* $\rho = .277$, $p = .015$); see Table 10.

***4-category “awareness” correlated with Occupation grouping A vs. B, C, D:***

After controlling for Years of Experience, the resulting partial Spearman correlation between 4-category “awareness” and the variable indicating Occupation group A (Ergonomist or Human Factor Specialist) vs. Occupation group (B, C, D) is positive and significant (*Spearman partial* $\rho = .245$, $p = .031$); see Table 11.

Table 10
3 category "awareness" correlated with Occupation grouping A vs. B, C, D

| Control Variables | | | Aware_3cat | Occup2b |
|---|---|---|---|---|
| YoExp | Aware_3cat | Correlation | 1.000 | .277 |
| | | Significance (2-tailed) | . | .015 |
| | | Df | 0 | 75 |
| | Occup2b | Correlation | .277 | 1.000 |
| | | Significance (2-tailed) | .015 | . |
| | | Df | 75 | 0 |

Table 11
4-category "awareness" correlated with Occupation grouping A vs. B, C, D:

| Control Variables | | | Aware_4cat | Occup2b |
|---|---|---|---|---|
| YoExp | Aware_4cat | Correlation | 1.000 | .245 |
| | | Significance (2-tailed) | . | .031 |
| | | Df | 0 | 75 |
| | Occup2b | Correlation | .245 | 1.000 |
| | | Significance (2-tailed) | .031 | . |
| | | Df | 75 | 0 |

### 4.2.2 "Awareness" and OC or PC

To begin, correlations between the demographic variables and the Commitment scores (both Organizational and Professional) were calculated. It was found that Age was not significantly correlated with either OC ($\rho$ = .079, $p$ = .493), or with PC ($\rho$ = .156, $p$

= .175). Years of Experience and Work Volume in ergonomics were also not significantly correlated with OC or PC scores.

To account for the significant effects of demographic variables on both "awareness" and Commitment scores, partial correlations between numeric "awareness" and Commitment scores were calculated. After controlling for demographic variables in this manner, there are neither significant relationships between numeric "awareness" and OC (*partial* $\rho = .072$, $p = .545$), nor between numeric "awareness" and PC (*partial* $\rho = .019$, $p = .872$).

Table 12 and Table 13 demonstrate that every "awareness" category scores higher (on average) in PC than in OC. A matched-pairs t-test on all 77 respondents at once shows a significant average difference of 0.46 units, and considers this a large effect size ($t_{(76)} = 5.323$, $p < .001$, $r = .521$, *95% CI* = [0.29, 0.63]). When each of the 3-category "awareness" groups was considered in a separate matched-pairs t-test, the difference of (PC – OC) proved similarly significant within each category. Table 13 in particular suggests that the difference between PC and OC (PC – OC) decreases as one moves from "low awareness" to "high awareness". PC remains relatively stable, while OC increases steadily with "awareness".

In Table 12, mean commitment scores do not follow a stable pattern across "awareness" levels for 4-category "awareness": the "moderately high awareness" category has higher average Commitment than the "very high awareness" category; and

the "very Low awareness" category scores higher average PC than the "moderately low awareness" category.

Table 12
4-category "awareness" scores in OC and PC

| **Count** | **4 cat "awareness"** | **OC mean** | **PC mean** |
|---|---|---|---|
| 20 | **v.hi** | 4.078 | 4.428 |
| 26 | **m.hi** | 4.299 | 4.538 |
| 22 | **m.lo** | 3.563 | 4.205 |
| 9 | **v.lo** | 3.389 | 4.296 |

Table 13
3-category "awareness" scores in OC and PC

| **count** | **3 cat "awareness"** | **OC mean** | **PC mean** |
|---|---|---|---|
| 40 | **Hi** | 4.213 | 4.488 |
| 29 | **mid** | 3.860 | 4.307 |
| 8 | **Lo** | 2.722 | 4.167 |

This lack of clear trend across 4-category "awareness" makes sense given that numeric "awareness" (based on Q4.7-Q4.9) is not correlated with Commitment, yet is "built-in" to the definition of the 4 "awareness" categories. Consequently, further analysis focused on 3-category "awareness", which considers only Q4.5 and Q4.6.

Prior to ANOVA analysis of Commitment scores across levels of 3-category "awareness", Kolomogorov-Smirnov normality tests were performed. PC exhibits a normal distribution ($D_{(77)} = .078$, $p > .200$) with slightly positive skew ($z_{skew} = 2.347$, $p = .009$ (1-tailed)) but no discernible kurtosis ($z_{kurt} = 0.275$). OC also exhibits a normal distribution ($D_{(77)} = .051$, $p > .200$) with no discernible skewness ($z_{skew} = 0.058$) nor kurtosis ($z_{kurt} = 0.569$). Next, note that Levene's tests for homogeneous variance across levels of 3-category "awareness" (Table 14) are satisfied for both OC ($F_{(2, 74)} = 0.407$, $p$

= .667), and PC ($F_{(2, 74)} = 0.434$, $p = .650$). The ANOVA analyses (Table 15) show that PC does not differ significantly across "awareness" categories, but OC does, and there is a large linear effect ($F_{(1, 74)} = 20.778$, $p < .001$, $\omega = .454$).

To determine significant group differences where sample sizes are quite different in each "awareness" group, post-hoc analyses were performed using the Hochberg's GT2 option in SPSS (Field, 2013). Figure 6 shows that "high" and "mid" "awareness" categories are not significantly different from each other with respect to average OC, but both differ significantly from the "low" "awareness" category.

To summarize: higher "awareness" (across the 3 categories) tends to bring higher OC, while PC increases slightly, but not significantly. The difference in Commitment (PC – OC) *does* get smaller with higher "awareness", but the small sample size in the "low" "awareness" category implies that the much larger observed difference (1.44 units) is just barely more significant than the smaller differences in the "mid" (0.45 units) or "high" (0.28 units) "awareness" categories.

Table 14
Test of Homogeneity of Variances

| | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|
| OrgCom_mean | .407 | 2 | 74 | .667 |
| ProCom_mean | .434 | 2 | 74 | .650 |

Table 15
ANOVA (Commitment X 3-cat “awareness”)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| OrgCom_mean | Between Groups | (Combined) | | 15.002 | 2 | 7.501 | 10.526 | .000 |
| | | Linear Term | Unweighted | 14.806 | 1 | 14.806 | 20.778 | .000 |
| | | | Weighted | 12.858 | 1 | 12.858 | 18.044 | .000 |
| | | | Deviation | 2.143 | 1 | 2.143 | 3.008 | .087 |
| | Within Groups | | | 52.732 | 74 | .713 | | |
| | Total | | | 67.733 | 76 | | | |
| ProCom_mean | Between Groups | (Combined) | | .980 | 2 | .490 | 1.022 | .365 |
| | | Linear Term | Unweighted | .686 | 1 | .686 | 1.431 | .235 |
| | | | Weighted | .974 | 1 | .974 | 2.032 | .158 |
| | | | Deviation | .006 | 1 | .006 | .012 | .912 |
| | Within Groups | | | 35.482 | 74 | .479 | | |
| | Total | | | 36.462 | 76 | | | |

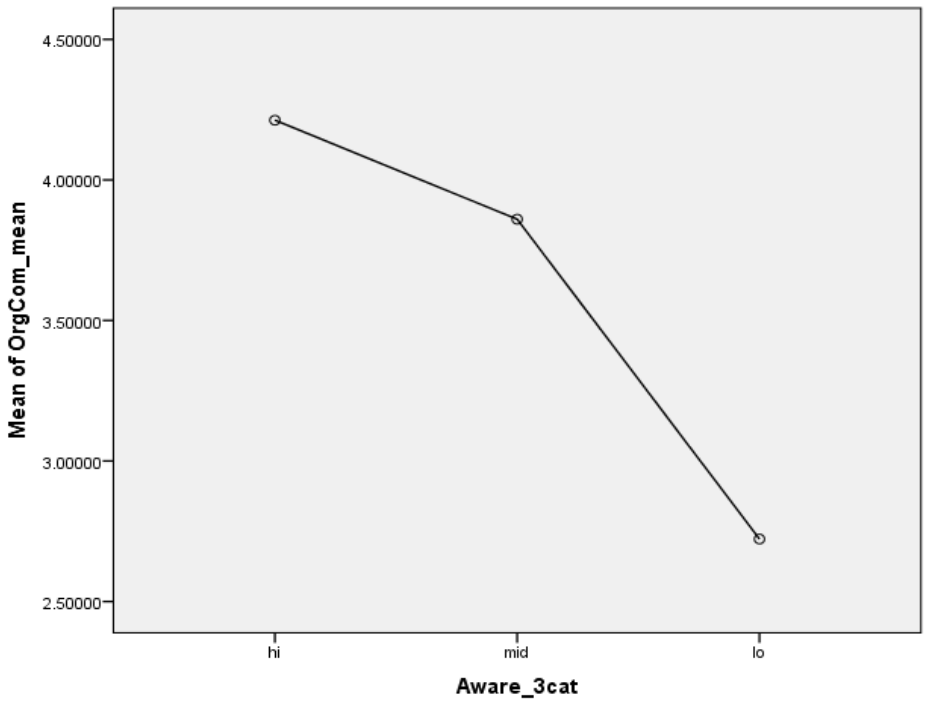


**Figure 6: 3-category "awareness" groups versus average OC scores.**

### 4.2.3 Employer support and "awareness"

Table 16 demonstrates that average numeric "awareness" (A_mean) decreases as the 3-category Support variable moves from "full" to "none". This decreasing trend is evident in the averages of each of the questions that define numeric "awareness", with the average response for Q4.7 again somewhat lower (in all Support categories) than responses to Q4.8 and Q4.9, potentially reflecting confusion interpreting Q4.7. It is likely that this question was misinterpreted, since the intent could be understood to mean that ergonomics is used to prevent MSIs *in reality* as opposed to *in theory,* in which case many EPs would have "agreed" since it was clear in the comments that there are struggles to practice ergonomics for reasons other than MSI in most work settings.

Table 16
Numeric "awareness" decreasing with 3-category Support groups

| count | Support | A_mean | A_Q4.7_mean | A_Q4.8_mean | A_Q4.9_mean |
|---|---|---|---|---|---|
| 57 | **1_full** | 0.626 | 0.053 | 1.035 | 0.789 |
| 17 | **2_mod** | 0.353 | -0.324 | 1.029 | 0.353 |
| 5 | **3_none** | 0.100 | 0.100 | 0.100 | 0.100 |

The small sample of respondents in the "none" support category ($n = 5$) will limit the strength of conclusions from the non-parametric tests performed to assess the significance of this trend. The Kruskal-Wallace test fails to identify significant differences in the average ranking of responses within each category ($\chi^2_{(3)} = 2.743$, $p = .254$). The Jonckheere-Terpstra test is perhaps more appropriate given the inherent ordering of Support categories, and the result is suggestive of a real difference in "awareness" across the 3 Support levels ($z_{JT} = -1.680$, $p = .093$). This result is backed up with non-parametric correlations between Support and numeric "awareness" which are approaching significance (*Kendall's* $\tau_b = -.159$, $p = .093$; *Spearman's* $\rho = -.186$, $p = .100$).

Next, "awareness" controlled for demographic variables was used in an ANOVA analysis to determine significant differences. Levene's test for the homogeneity of "awareness" variance across Support categories failed, so the Welch and Brown-Forsythe robust tests for equality of means were referenced, but failed to identify significant

differences between Support categories. Furthermore, when relationships with the categorical "awareness" variables were considered, there emerged no significant differences in "awareness" classification across Support categories. These results are supported by the bar graphs in Figure 7 and Figure 8.

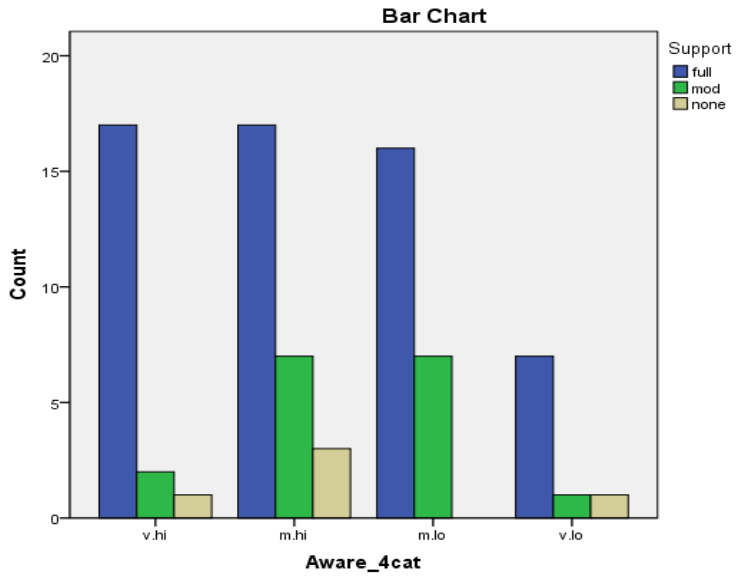


**Figure 7: 4-category "awareness" scores across three Support categories.**

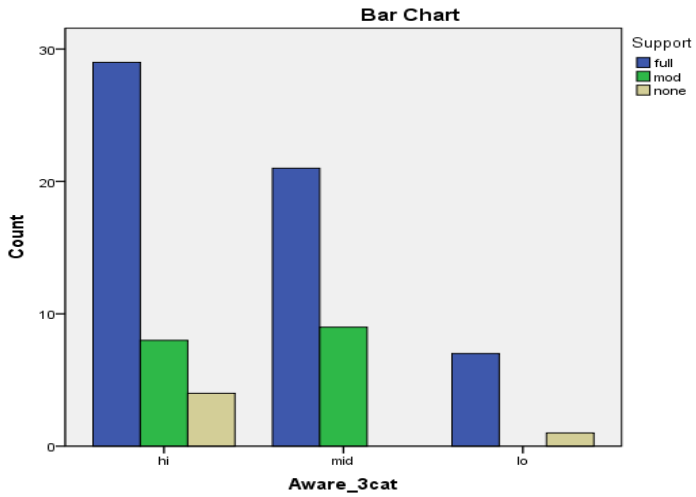


**Figure 8: 3-category "awareness" scores across three Support categories.**

In order to achieve a better balance of respondents between Support categories and reveal any potential differences in "awareness" measurements or classification, a new variable was created to compare Support groups "moderate" and "none" (coded as 0) against Support group "full" (coded as 1). A biserial correlation is appropriate for measuring the relationship between the numeric "awareness" variable and the new dichotomous variable expressing a continuum of Support ($r_{bis}$ = .249, $p$ = .099). This measure is controlled for demographic variables and indicates a positive moderate effect between numeric "awareness" and moving up the Support scale from "none/moderate" to "full". An independent samples t-test finds a trend towards significant positive difference in average "awareness" between the dichotomous Support groups (group 0 – group 1), once controlled for demographics ($t_{(77)}$ = 1.663, $p$ = .100, *95% CI* = [-0.88, 0.08]).

In all analyses where correlations are calculated directly or presented as effect sizes in t-tests or ANOVAs, they are classified as large when above 0.5, moderate when above 0.3, and small otherwise. When $\omega$ effect sizes are presented they are considered large if above 0.4, moderate if above 0.25 and small otherwise (Kirk, 1996).

### 4.2.4 Other findings

***Years of Experience***

Years of Experience was found to be very strongly correlated with "awareness". Although this had not been predicted in the hypotheses, it is logical and should not be unexpected as a result. The correlation between Years of Experience and Occupation categories was found to be near zero and not significant (*Spearman's* $\rho$ = -.092, $p$ = .422),

however, showing that there was not a skewed number of "experienced" EPs in one profession over the others. It cannot be said that the most experienced EPs were concentrated within any particular occupation(s) and thus confounding true differences in "awareness" across occupational categories.

***Gender***

Gender was not found to have a significant correlation with "awareness", however there was a significantly positively correlation with both OC (*point-biserial* $\rho = .223$, $p = .052$), and PC (*point-biserial* $\rho = .232$, $p = .042$). Hence, being a female respondent was associated with higher Commitment scores.

# CHAPTER 5: DISCUSSION

## 5.1 Introduction

Ergonomics, as a discipline, has been evolving for decades and addressing ever-increasing sizes of organizational systems in the midst of changing complex sociotechnical environments. The variety in the academic and professional backgrounds of the persons who practice ergonomics in their work either fully or in part, is very large, owing in part to the very nature of the field and its breadth of application, and to the continuing growth and changes to the nature of the systems within which we work.

The control of psychosocial hazards in the workplace has been shown to be an effective contributor to developing a psychologically safe, if not healthy, work environment. Ergonomics has been shown to be effective and relevant in the control of job design and work organization, such that it can be used to help control workplace psychosocial hazards without the involvement of MSI prevention as a trigger for action. Nonetheless, ergonomics appears to be perceived differently amongst its large and varied group of practitioners (EPs), in terms of its benefits in a psychologically healthy workplace.

### 5.1.1 "Awareness" and EPs

The study supported Hypothesis #1, which asked whether EPs are aware of a direct relation between the application of ergonomics and the control of workplace psychosocial hazards, independently of the MSI investigation as a prompt. It identified

that EPs are aware of the relationship (see Annex C for statistical analysis of "awareness") and that the highest level of awareness was amongst those EPs who self-identified as being "Ergonomists" or "Human Factors Specialists" compared to the other groups of EPs who participated in this survey. The latter is illustrated in 4.2.1, "Awareness and EPs", Table 9 and Table 10.

Williams and Haslam (2006) identified similar results in their work with 54 EPs to identify the similarities between the types of ergonomics services, which they each offered. It was evident that the Ergonomists in the group had a greater depth and breadth of understanding and a more philosophical approach to their work. It was likely that this was a result of their intensive training and the fact that ergonomics made up all (and not a part) of their workload.

The results of this study support the notion that EPs who are not Ergonomists or HF specialists, have less "awareness" of how ergo can be applied to the control of workplace psychosocial hazards than Ergonomists/HF specialists. The concern is that there are likely less Ergonomists/HF specialists in the workforce than there are other EPs, which could possibly shift the common understanding of ergonomics further away from the systems and holistic focus and further towards a more physical approach for the purpose of controlling MSI hazards in workplaces. Conceivably a similar scenario, regarding the uncontrolled message to the public on the occupation's scope, could also be of concern to other non-regulated professions, such as Industrial Hygiene or Human Resources.

The skewed understanding about ergonomics towards its physical domain may also be a result of the ongoing debate on its name. As long as there are two names for the same field, (or as long as there are beliefs that these are two different fields), and as long as there is significant disagreement amongst Ergonomists, it will be no surprise that there is less "awareness" amongst EPs than would be desirable. OHS Regulations also play a role, since in Canada MSI prevention related regulations are also in some cases, referred to as "ergonomics regulations". If EPs are concentrated in government settings there is an opportunity to influence policy makers with improved awareness of what benefits ergonomics can have on the psychological health and safety climate in a workplace. If social policy changes to better embrace the breadth of ergonomics how will this be successful if professionals are under-informed?

In an informal investigation of the phrase "What is Ergonomics" performed in Google by the author (March 14, 2016), 70% of the first 33 (n = 23) "hits" (after the professional ergonomics and human factors association sites were eliminated from the count) only centered on physical characteristics of the field. The weak public definition of ergonomics is likely a product of inconsistent levels of "awareness" amongst EPs, and of disagreement on the name of the field.

This study found that Years of Experience had a strong correlation with "awareness" levels, where the larger the Years of Experience, the higher the levels of "awareness" were demonstrated, regardless of the Occupation (4.2.1 "Awareness and EPs" and Table 6 & Table 7 and Annex C). This implies a learning factor that comes from

being exposed to and practicing ergonomics for a number of years, regardless of the setting or the Occupation (4.2.4 Other findings). This could be a logical progression in any profession and lends promise to the notion that with time in the field, all EPs come to the same understanding of the breadth of ergonomics. The challenge then, is to find ways to ensure that it occurs sooner in an EP's career.

As expressed by participants in the study, a very real concern is that even when EPs (of any Occupation) are fully aware of the breadth of ergonomics, their ability to practice to its fullest extent is limited by what employers and referral sources are hiring them to do (4.1 Descriptive Analysis, "Survey Comments Analysis"). Based on their experiences, as well as on the very widespread common understanding of ergonomics, this is reality for many EPs. There is a need for the public to understand ergonomics by having it more accurately portrayed by its practitioners, EP professional associations, academia, policy makers and any others who are interested in seeing the field reach its potential. Broadly speaking, this is a common finding amongst researchers and commentators who have also found that there is a less than accurate or well-informed perspective amongst a number of stakeholders, on the field of ergonomics (Chung & Shorrock, 2011; Helander, 1997; Hermans & Peteghem, 2006; Hollnagel, 2001; MacDonald, 2006; Marras & Hancock, 2014; Meister, 1997; Piegorsch et al., 2006; Whysall, Haslam & Haslam, 2004; Williams, 2010; Wilson, 2000; Wilson, 2012).

### 5.1.2 Awareness and OC & PC

The study supported Hypothesis #2, which asked if EPs who can identify a direct relation between ergonomics and workplace psychosocial hazard control (i.e. those with a high "awareness") demonstrate stronger PC or OC. There was no significant difference in PC across levels of "awareness", however there was a trend of significantly decreasing OC from a high level of awareness to a low one (4.2.2 "Awareness" and OC or PC, and Table 14). In other words, a higher "awareness" (across 3 categories) tends to bring higher OC (4.2.2 "Awareness" and OC or PC), suggesting that there could be improvements made at the organizational level between EPs (of any occupation) and their employers where there is a "low awareness". Figure 6 shows the significant difference between the OC of the mid to high "awareness" categories and the low "awareness" group. It may not be coincidental in that case, that the highest levels of employer support correlated positively with the highest "awareness" groups (see 5.1.3). Depending on which type of OC (affective, continuance or nominal commitment) is strongest in the group of "low awareness", some tailored solutions could be developed to help the relationship, which could benefit both parties (although this was not one of the aims of this study). Administrators would be able to use information about the OC and the PC of their employees, to enable a culture or an environment, which would be conducive to increasing the Commitment of employees, thereby improving the quality of their services (Giffords, 2003).

Another interesting perspective is that the type of PC that EPs exhibit may be important for professional ergonomics associations to learn more about, since the PC in

this study was very similar from “low awareness” to “high awareness”. If the PC is more strongly affected by one type of Commitment over another at a particular level of “awareness”, perhaps this information could be used to help associations further understand the perspective of the EPs in the field. Not only employers can benefit from improving their retention efforts, as professional associations face a similar task in order to meet the needs of their current members, and to attract new members to the profession.

### 5.1.3 Employer support and “awareness”

Hypothesis #3 asked if EPs who have employer support for professional development (i.e. access to peer reviewed journals and professional development opportunities) demonstrate a greater awareness of the relation between ergonomics and workplace psychosocial hazard control than EPs that do not have this type of employer support.

Results showed that there is a positive moderate effect between “awareness” and moving from none/moderate employer support to full employer support (4.2.3 Employer support and
“awareness”). Due to the very small sample size in the group of “no support”, the grouping together of the “none” and “moderate” support level groups was necessary for appropriate analysis. Perhaps if there were larger sample groups to work with, further light could be shed on the effects of employer support.

EPs who answered a survey for Chung and Shorrock's (2011) research on the research/practice gap in ergonomics, reported a lack of access to professional, peer reviewed journals and that this was the primary reason for not using research outcomes in their work. Without support by employer organizations to provide access to databases or to journal subscriptions, many EPs would be required to access them by purchasing them with their own funds. This can be very expensive, and is rarely done. U.S. natural resource agency employees who perceived participation in professional development opportunities and reviewing peer reviewed journals as being important, were those with the highest levels of education in the sample, and also had the highest PC than their coworkers, and a higher PC than OC (Lauber, Taylor, Decker & Knuth, 2010). The similarity to this study in terms of the highest "aware" category also having the highest OC and PC is interesting. It may be possible that the EPs with the highest awareness are also those that feel it is important to access peer reviewed journals, so employer support may be very effective in improving the OC in that case as well.

Employers who can provide only limited access to peer reviewed journals may be more likely to do so if the journal is relevant to the type of service or products which the organization offers. In addition, since so many EPs are not actually certified Ergonomists they may be attracted to journals from other areas of practice or academia especially if their work takes place in non-ergo settings as so many do in this study. Nevertheless, "practitioners need to recognize the value of incorporating research in their practice and professional development. In order to gain greater opportunities to read research at work and to conduct and apply research in their practice, practitioners will

need to actively raise their own profiles and rally support from their organizations" (Chung and Shorrock 2011).

In a survey of U.S. employers of newly hired ergonomists, Rantanen and Moroney (2012) were provided with a very clear message regarding the training that was lacking amongst ergonomists whom they had hired. That was: practice in design, project management, working in interdisciplinary teams, and being able to make persuasive arguments for human factors in all project phases. These areas of knowledge might not necessarily be required for, or taught in any one specific discipline, and could be suited to any number of educational programs. Including these areas of knowledge in an ergonomics undergraduate or graduate program would likely be beneficial. If these courses could be made available to EPs (particularly newly practicing ones) by learning institutions, then employer support to access them might be a very positive benefit for the EP. It may help to increase their level of "awareness", even when the courses are not directly relevant to psychosocial hazards control. This may also lend itself to an improved OC and PC.

### 5.1.4 Other considerations

Statistics Canada (2015) shows how different the population numbers are between different generations (i.e. Baby Boomers, X-Generation etc). Professional organization memberships may experience similar patterns; for example in a membership survey performed by the HFES in 2014 and 2015, the majority of members who responded were considered to be "Baby Boomers" (born between 1946 and 1964) (de Falla, C., personal

communication, February 9, 2016). Many professions are struggling with how to perform the knowledge transfer needed between generations to keep information from disappearing; it is not clear if the Ergonomics profession demographics in North America at least, currently follow a similar pattern as the overall population. It is clear however, from this study that years of experience in the field have helped to improve and strengthen EPs' "awareness", and that OC decreased with the level of "awareness". This may indicate that knowledge transfer within an organization may not be helpful, rather that the profession itself may be the source for EPs to gain that knowledge from. In addition to the need to plan for knowledge transfer, it may be of interest to employers and to professional ergonomics associations, that there can be a difference between Baby Boomers and Gen-Xers in the nature of their commitment to their professions (Tang et al., 2012).

It may be useful to consider how EPs relate to the values of the profession at a much earlier stage of their careers. The socialization of a professional has been studied for the last decades, and shows a variety of positive features of the process, both for the professional and for the organizations within which they work (Ellis et al., 2015; Goldenberg & Iwasiw, 1993; MacLellan, Lordly & Gingras, 2011). Professional socialization or "professionalization" is described by Goldenberg and Iwasiw (1993) as a "complex process by which the content of the professional role (skills, knowledge, behaviour) is learned and the values, attitudes and goals integral to the profession and sense of occupational identification which are characteristic of a member of that profession are internalized" (p. 4). The required education for an Ergonomist is not clear-

cut. There are requirements by the CCCPE for core competencies as laid out by the IEA, and these are required to be a part of the education for certification. Due to the fact that ergonomics is not regulated however, these competencies are not necessarily recognized by all EPs or by their employers. Due to the varied backgrounds of EPs, it is likely that the socialization of an Ergonomist into their profession during their education may either be very weak, or non-existent. This lack of socialization may add to the many reasons that EPs are not consistent in their perception of ergonomics and how it can be applied, in this case beyond the MSI related control of psychosocial hazards in the workplace.

Many EPs' work products do not take into consideration the effects of the sociotechnical system(s) within which their subject of work is situated. A possible result is that the microergonomics aspect of the work is "human centred" and initially safe, but that it does not function well within the social and organizational systems within which they are utilized (Kleiner et al., 2015).

Macroergonomics can clearly be used in workplaces to assist in controlling psychosocial hazards or in preventing various sociotechnical characteristics of work from becoming a hazard. This can translate into the ability to contribute effectively to system optimization and health and well being, as outlined by the IEA definition. One means of achieving this in Canada could be through OHS regulations, since there is a clear shift currently underway in the liability of employers to provide a healthy and safe workplace, which includes psychological safety (Shain, 2010). Since MSI regulations are already in place in a number of provinces, this might be an avenue for regulating some job design

characteristics that would improve psychological health and productivity through ergonomics. If the EP population is not clearly aware of this relation however, and is not able to articulate it and advocate for it in large numbers, this opportunity could be lost.

The evolution of the field can have some very far-reaching implications, depending on how the breadth or even the potential breadth of ergonomics is perceived and understood. EPs will need to become very aware of the full system in which their practices take place (i.e. contextualize their work), in order to help to contribute to the overall success and well being of systems small or large. Lange-Morales, Thatcher and Garcia-Acosta (2014) suggest that the education and awareness of Ergonomists of specific values could also contribute significantly to a desired shift in ergonomics. Increased awareness and need for sustainability due to globalization, changes in work management and changes in organizational design have resulted in the continued movement in the ergonomics evolution (Kubek, et al., 2015; Thatcher & Yeow, 2015; Zink & Fischer, 2013). Based on the assumed preference amongst all citizens to strive for the characteristics of a "good society", it is likely that for the positive effects of ergonomics on people's wellbeing to be maximized, the boundaries of ergonomics may need to be revisited (Jordan, 2012). In the case of the findings from this study, the less than consistent "awareness" amongst EPs may present a challenge for the field to further expand its boundaries. It may however, benefit from the change provided that it is clear to the rest of the stakeholders that the change is taking place.

## 5.2 Study limitations

The range of Occupations that was surveyed (and that responded) was a limiting factor. For example the study did not include psychologists (other than Occupational Health Psychologists) or usability specialists. Only EPs who were members of the professional associations or of certain social media sites, or who knew people who had received an email invitation had a chance to participate. Because participants self-selected to respond, it may be the case that only those who were disproportionately committed to the field of ergonomics participated.

Results of the study were limited by the small sample size of participants, and that they were not more homogeneously distributed across the Occupations of EPs. The sample for this study consisted of more Ergonomists than any other Occupation identified by participants. This may have been a product of the limiting question in the survey, of having ergonomics as no less than 25% of an EP's workload. This may have contributed to the very small numbers in some individual EP Occupations. The ratio of Ergonomists to other EPs may have been significantly changed if that restriction had not been implemented, and a more realistic ratio of responses may have been generated. If the EPs' responses from Occupational groups B, C and D were more representative of their likely numbers in reality compared to Occupation A, then hypothesis #1 may have been even more strongly supported. Similarly, the "awareness" of Occupations B, C and D may have been significantly higher than expected. Either way, greater responses from Occupations B, C and D would have been approaching a more realistic representation of the numbers of the EPs in their respective Occupations.

Respondents were asked about their PC regarding their own profession, which may not be "Ergonomist" in their minds. For instance an Occupational Therapist who identifies himself as an Ergonomist may have answered the PC questions from an OT profession perspective, since that is the licensing and therefore possibly the dominant profession in their mind. As a result, the results of this study may not be a reflection of the participants' PC for the ergonomics profession. Other PCs who clearly did not identify themselves as an Ergonomist or Human Factors specialist may be even more likely to be thinking about their own professional communities (e.g. OHS or Industrial Hygiene). This may account for the consistent PC scores regardless of "awareness" levels.

# CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

## 6.1 Conclusion

EPs who are Ergonomists or Human Factors specialists, demonstrate a higher awareness of the direct relation between ergonomics and psychosocial hazard control in the workplace ("awareness"), than other groups of EPs, however EPs of all Occupations demonstrate the highest levels of awareness with greater numbers of years of experience in the field. The most significant difference across occupations in level of awareness is between Ergonomists/Human Factors specialists and OHS Professionals.

OC appears to increase with "awareness" levels. This implies that there are lessons to be learned by employers or HR professionals who are interested in improving the quality of an EP's connection with their employing organization while simultaneously improving their own awareness of ergonomics and psychosocial hazard control.

The type of work performed by EPs (of all kinds) appears to be severely limited by the environment in which the work is carried out or by the expectations of their employers. In other words, as long as it is the expectation that ergonomics services will be limited to office ergonomics and MSI prevention exclusively, the services that are requested, provided and paid for will remain as such. EPs who report employer supported access to both peer reviewed journals and to professional development opportunities, appear to demonstrate a greater degree of "awareness" than those EPs who have little or no employer support for this kind of access.

Ergonomics continues to evolve and expand its reach and application, including approaches such as "neuroergonomics" and ever-widening systems such as the social and natural environment, or sustainability. The profession, (its practitioners, professional associations, academics and researchers) have a responsibility to allow the field to provide the benefits it can provide. This will require some effort on the part of all parties to improve the overall understanding by EPs, of the field's breadth. This study explored one aspect of that awareness and makes some suggestions for helping employers and EPs to work together and to work with the breadth of ergonomics.

## 6.2 Recommendations

The following are recommendations made to professional associations representing Ergonomists in Canada, academia, employers of EPs, and EPs themselves.

Professional ergonomics associations and their membership should be developing opportunities for improving the contribution that ergonomics can make to create psychologically healthier workplaces. This could take place by creating partnerships with other interested groups, such as mental health associations, occupational health and safety associations, business associations, unions, standards organizations, research groups or policy makers. Through the promotion of ergonomics in its entirety, these groups can begin to identify opportunities, which they may not have previously considered, where ergonomics can assist them in their objectives. Professional associations in Canada, together with the IEA, need to continue to work towards an improved understanding and marketing of the breadth of the field. To achieve this, the knowledge and experiences of

their membership will assist in providing valuable input and strategic planning. Part of this plan may need to include a strategy for how to arrive at a more consistent practice of referring to the field. One option is to aim for using the terms Human Factors and Ergonomics as synonymous (at least in the English language). It might be useful to revisit an exploration of the difference between the French and English understanding of "Human Factors" in order to identify an acceptable unified approach. Professional ergonomics associations should play a role in the ongoing efforts to educate employers on what an Ergonomist is, and how to identify someone who is qualified to act as one.

There is a need for graduates of ergonomics programs to have been provided with some form of "socialization" through their education in ergonomics. In addition, "there needs to be greater attention in the professional preparation of Ergonomists to the range and diversity in ergonomics practices and specifically, the importance of doing organizational work" (Theberge & Neumann, 2010). This may not be easy to achieve when there are so few choices for an ergonomics undergraduate degree, as opposed to undergraduate degrees which are not designated as ergonomics degrees but include many of the important courses needed by Ergonomists. There is a need to consider the benefits of developing undergraduate degrees, which can act as a foundation for Ergonomists, who would then move from there into more specialized areas of practice in ergonomics. There are only a handful of universities in Canada now that have begun to develop or have an ergonomics undergraduate degree which has the word ergonomics in it. Otherwise, there are many universities with degrees and courses that lend themselves well to the field, however from the perspective of the person who is looking for an "ergonomics education"

the many different names and structures could be daunting or confusing. Since the CCCPE has built its certification on the internationally recognized education and competencies put forward by the IEA, it is suggested that there be a concerted effort by academia and professional associations to work together to develop ergonomics degree programs that will direct graduates towards the requirements of certification. Some universities and colleges are right now working on this approach, in cooperation with the CCCPE. It will be exciting to see their graduates come into the workforce, possibly more "socialized" to the field than has previously been possible at least in Canada.

Researchers in the ergonomics field might help to improve the overall "awareness" of EPs and others by publishing in journals not only in the ergonomics field, but in other areas of interest as well. This would provide exposure to ergonomics and its benefits to different groups of readers.

Employers of EPs should strategize with their employees to find opportunities for offering a wider range of ergonomics applications, which will allow for the full breadth of the field to be practiced, amongst their services. This is not to say that every EP can work in the field in its fullest context, however considering the comments by many participants in this study, there is considerable room for improvement in how their skills and knowledge are utilized within their current work demands.

Employers of EPs are recommended to consider means of providing access to peer reviewed ergonomics journals, and other professional development opportunities to their employees, in order to help to encourage their greater "awareness". The aim is to

improve not only the access by EPs to the newest approaches and philosophies in ergonomics, but to improve their use of the full breadth of ergonomics in their work and to contextualize their work more easily. Journal articles that appear to be most favoured by EPs provide practical information (Chung, Williamson & Shorrock, 2014). This is in line with the comments of some participants in this survey, who stated that it is difficult to take the time to read the articles if they are not practical and more directly associated with their work.

It is also recommended that EPs' employers take a greater interest in the nature of their employees' commitment levels and types. Employees who have a strong continuance OC may require different changes to their work relationship and design than those who demonstrate a strong affective OC. By understanding the nature of their Commitment to the organization, and how that relates to the work they do, an employer and the EPs can work together to develop strategies for improvement or retention.

Graduating students who are considering a career in ergonomics should consider becoming a member of a professional ergonomics association and specifically, beginning the work of applying for and becoming a certified Ergonomist. This type of unity in a profession can help to clarify its meaning to the public, to strengthen its own ability to develop partnerships and ties with other influential groups, and to help the profession to mature and grow in ways that can benefit everyone. The recommendation made by Rice and Duncan (2006) that we need to advocate for the support and integrity of the field is supported in this study.

EPs in the field who struggle to be able to practice ergonomics in its broadest sense in their work due to various limitations of funding or awareness of others about ergonomics, need to ensure that regardless of the limitations, they take a systems level perspective of their work. There is always a need to understand the broader context of the system (to contextualize) in which the work takes place, no matter how narrowly defined it is. This will help to ensure that the ensuing problem solving is based on the appropriate questions, and therefore appropriate solutions are developed (Wilson, 2014).

## 6.3 Future research

Given the imbalance between numbers of certified Ergonomists and others who practice ergonomics, and the difference between Ergonomists and others in "awareness" as identified in this study, it would be helpful to study the "awareness" amongst EPs who practice ergonomics for less than 25% of their workload. This group was not included in the survey, however their perception and understanding of the field may be representative of a large group of practitioners. Knowing more about their relationship with ergonomics might help with the development of strategic plans for communicating with EPs about the breadth of ergonomics.

A meta-analysis of research involving the use of ergonomics principles to directly affect the psychological health and safety of workers without the need to specify musculoskeletal injury prevention as a motivator would be very helpful. The results of such an analysis would help to either reveal outcomes of using ergonomics as a means of psychosocial hazard control in the workplace, or it would identify a gap in research. In

either circumstance, the information can be used to further strengthen or build on the ergonomics profession. These studies should include a focus on the comparison of the approach taken in "francophone ergonomics" versus "anglophone ergonomics" to highlight any differences between the understandings of both groups of the term "human factors". This may help in the development of a more unified approach on the choice of a title for this field, at least in Canada.

Employers of EPs would benefit from further research that helps to characterize the OC and PC of their employees, (i.e. identify the types and strengths of OC or PC) since this information could be used to develop a practical strategy for quality and retention improvements. It would be interesting for employers to understand what factors are found to be important to EPs for which would a higher OC might be achieved, and possibly a higher "awareness" as well. Further research would also be helpful for studying the difference between the "awareness" and the OC/PC of EPs who are employed by a company for their internal ergonomics needs, (e.g. Ergonomist working for a large Retail company) versus those who are employed by an ergonomics services company. The relationship identified in this study regarding the association of gender and both OC and PC (4.2.4. Other findings) should be further investigated.

Another interesting question is the nature of the OC and PC that EPs exhibit. Since affective, normative and continuance commitments are derived from different perspectives and experiences, they may have a strong influence on an EP's perspective where ergonomics and "awareness" is concerned. Further study in this area would be

helpful in the development of further plans and solutions for assisting EPs in their development in the profession.

To better understand how professional socialization theory applies to Ergonomists, a study on how or if socialization is achieved in different learning institutions in different countries would be beneficial. This would help to further develop strategy for academia where there is an appetite to develop a "true" ergonomics undergraduate (or other) learning program.

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# Appendices

## Appendix A: Survey including Consent Form

Perspectives on Ergonomics

Q55 **English translation will follow below**  Ce sondage est disponible en français ou en anglais. Veuillez choisir la langue préférée dans le menu déroulant situé du côté droit de cette page.  Au début du sondage, vous serez invité à lire un formulaire de consentement décrivant l'étude et ce qu'on attend de vous à titre de participant. À la fin du formulaire de consentement, vous serez invité à cliquer sur le bouton « Accepter » ou « Je n'accepte pas ». Si vous n'acceptez pas, vous n'aurez pas à répondre au sondage et ce dernier se fermera.

This survey is available in French or English.  If your preferred language is French, please chose it in the drop down menu on the right hand side of this page.  When the survey begins, you will be asked to read a Consent Form, describing this study and what to expect as a participant.  At the end of the Consent form, you will be asked to indicate either "Accept" or "I do not accept".  If you do not accept, the survey will be ended and your participation will not be expected.

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**Informed Consent Form**

| | |
|---|---|
| Title: | How well is the breadth of the ergonomics field understood by practicing professionals? |
| Researcher(s): | Linda Sagmeister, School of Human Kinetics and Recreation, Memorial University of Newfoundland, lsagmeister@mun.ca |
| Supervisor(s): | Dr. Scott MacKinnon, Professor, School of Human Kinetics and Recreation, Memorial University of Newfoundland, (709) 864-6936, smackinn@mun.ca |

You are invited to take part in a research project entitled "How well is the breadth of the ergonomics field understood by practicing professionals?"

This form is part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. It also describes your right to withdraw from the study. In order to decide whether you wish to participate in this research study, you should understand enough about its risks and benefits to be able to make an informed decision. This is the informed consent process. Take time to read this carefully and to understand the information given to you. Please contact the researcher, Linda Sagmeister, if you have any questions about the study or would like more information before you consent.

It is entirely up to you to decide whether to take part in this research. If you choose not to take part in this research or if you decide to withdraw from the research once it has started, there will be no negative consequences for you, now or in the future.

**Introduction:**

I am a part time graduate student at Memorial University of Newfoundland, School of Human Kinetics and Recreation. As part of my Masters thesis I am conducting research under the supervision of Dr. Scott MacKinnon of the School of Human Kinetics and Recreation.

**Purpose of study:**

The purpose of this survey is to gather information on how various professionals view and perceive ergonomics, and to gauge the degree of organizational support they receive at their workplace. The objective is to provide insight into the employer support that professionals practicing ergonomics may require in order to enhance their understanding and knowledge of the field in which they practice.

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**What you will do in this study:**
Participants in this study will take part in an anonymous online survey, in which questions will be posed regarding the nature of their work and their understanding of ergonomics/human factors as a field of practice. They will also provide information as to the type of employer support they receive with their current employer regarding their professional practice. Participants will be asked questions around how they perceive psychosocial hazards in the workplace.

**Length of time:**
Taking part in this survey will take approximately 20 minutes of your time to complete, and a progress bar will inform you on how much of the survey you have completed.

**Withdrawal from the study:**
If at any time you wish to withdraw from participating in the survey, simply exit the survey and it will not have been "submitted". Your information will have been deleted as a result. Once your completed survey has been electronically submitted however, your data can not be removed since all data is being anonymized.

There are no consequences whatsoever for withdrawal from participating in the survey, or from chosing not to participate in any manner.

**Possible benefits:**
Results from this study can be used to help identify opportunities for employers of Ergonomists and other professionals practicing ergonomics, to improve the strength of their professional services. The results can also benefit the Ergonomics profession by contributing to the body of knowledge around how ergonomists perceive their field of work, thereby leading to possible suggestions for improved support and initiatives for the professional associations supporting Ergonomics and Human Factors in Canada.

**Possible risks:**
There are no physical, emotional, social or financial risks for participants in this study.

**Confidentiality:**
The ethical duty of confidentiality includes safeguarding participants' identities, personal information, and data from unauthorized access, use, or disclosure. This will be achieved through the collection of data which does not include any identifiers such as names of participants or their employers and by working with aggregated data to report results of the survey.

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**Anonymity:**
Anonymity refers to protecting participants' identifying characteristics, such as name or description of physical appearance. Every reasonable effort will be made to ensure participants' anonymity; and they will not be identified in publications without their explicit permission.

Similarly to the confidentiality of any information provided for the survey, participants' identifying characteristics will not be provided to the Principal Investigator or the Supervisor. This will protect the anonymity of participants.

In the case where a participant wishes to disclose identifying characteristics for any reason, such as a name or contact information, this should be done in private correspondence with the Principal Investigator, and not in the body of the Survey.

**Recording of Data:**
Other than collection of survey results no other recordings of any kind will be obtained during the process of this work.

**Storage of Data:**
Electronic collected for this work will be stored on a password protected hard drive at the School of Human Kinetics and Recreation. Any hardcopy documentation relevant to the data will be kept in a locked filing cabinet at the School of Human Kinetics and Recreation. Access to the data will be by the Principal Investigator (Linda Sagmeister) and the Supervisor, Dr. Scott MacKinnon. Data will be kept for five years, as required by Memorial University's policy on Integrity in Scholarly Research, at which time it will be destroyed by shredding hardcopies and deleting software records of survey responses. Data will not be archived.

The on-line survey company, Qualtrics, hosting this survey is located in the United States. The US Patriot Act allows authorities to access the records of internet service providers. Therefore, anonymity and confidentiality cannot be guaranteed. If you choose to participate in this survey, you understand that your responses to the survey questions will be stored and may be accessed in the US. The security and privacy policy for the web survey company can be found at the following link: www.qualtrics.com/privacy-statement/

**Reporting of Results:**
Results of this study will be published in the form of presentations at conferences, as well as in journal articles. The thesis will be publically available at the QEII library. Results of the data collection will be reported only in an aggregated or otherwise summarized form.



- I accept
- I do not accept

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**Formulaire de consentement éclairé**

| | |
|---|---|
| Titre du projet : | Dans quelle mesure l'étendue du domaine de l'ergonomie est-elle bien comprise des praticiens? |
| Chercheuse : | Linda Sagmeister, School of Human Kinetics and Recreation, Memorial University of Newfoundland, lsagmeister@mun.ca |
| Superviseur : | Scott MacKinnon, Ph. D., professeur, School of Human Kinetics and Recreation, Memorial University of Newfoundland, (709) 864-6936, smackinn@mun.ca |

Vous êtes invités à participer à un projet de recherche intitulé « Dans quelle mesure l'étendue du domaine de l'ergonomie est-elle bien comprise des praticiens? »

L'information dans ce formulaire fait partie du processus d'obtention du consentement éclairé. Elle a pour but de donner une idée générale de ce que comporte la recherche et de ce que vise votre participation. Elle décrit également votre droit de vous retirer de l'étude. Pour vous aider à décider si vous souhaitez participer à cette étude, vous devez avoir suffisamment d'information sur les risques et les avantages de celle-ci afin de prendre une décision éclairée. C'est ce qu'on appelle le processus de consentement éclairé. Veuillez prendre le temps de lire attentivement ce formulaire et de comprendre les renseignements qui vous sont fournis. Pour toute question au sujet de l'étude ou pour obtenir de plus amples renseignements avant de donner votre consentement, veuillez contacter la chercheuse Linda Sagmeister.

La participation à cette étude est volontaire. Le fait de ne pas y participer ou de vous désister n'aura aucune conséquence négative pour vous, soit maintenant ou plus tard.

**Introduction :**

Je suis étudiante de 2$^{e}$ cycle à temps partiel à la School of Human Kinetics and Recreation de la Memorial University of Newfoundland. Dans le cadre de mon mémoire de maîtrise, je réalise une recherche sous la supervision du professeur Scott MacKinnon, Ph. D., School of Human Kinetics and Recreation.

**Objectifs de l'étude :**

Le sondage réalisé dans le cadre du projet de recherche a pour objet de recueillir des renseignements sur la façon dont les ergonomes praticiens perçoivent l'ergonomie et de mesurer le degré de soutien organisationnel que les ergonomes reçoivent en milieu de travail.

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La recherche vise à fournir des informations sur le soutien offert aux ergonomes par leur employeur afin qu'ils accroissent leur compréhension et leur connaissance du domaine dans lequel ils travaillent.

**Participation à l'étude :**
Les participants qui prennent part à cette étude devront remplir un sondage anonyme en ligne dans lequel des questions porteront sur la nature de leur travail et leur compréhension de l'ergonomie en tant que champ d'activité. Ils devront également fournir des renseignements sur le type de soutien qu'ils reçoivent de leur employeur par rapport à leur travail. Des questions seront également posées sur la façon dont ils perçoivent les risques psychosociaux en milieu de travail.

**Durée :**
Les participants auront besoin d'environ 20 minutes pour remplir le sondage. Une barre de progression indiquera le pourcentage du sondage qui est complété.

**Droit de retrait :**
Les participants sont libres de mettre fin à leur participation en tout temps en quittant simplement le sondage. De cette façon, aucune information ne sera transmise et les données seront supprimées.

Toutefois, une fois que le sondage aura été rempli et transmis électroniquement, il ne sera plus possible de supprimer les données puisqu'elles sont anonymes.

Vous pouvez décider de mettre fin au sondage ou de ne pas y participer sans aucune conséquence.

**Avantages possibles :**
Les résultats de cette étude contribueront à identifier des pistes pour les entreprises qui embauchent des ergonomes ou d'autres professionnels œuvrant dans le domaine de l'ergonomie afin d'améliorer leurs services professionnels.

Les résultats seront également utiles pour la profession puisqu'elles contribueront à enrichir les connaissances sur la perception qu'ont les ergonomes de leur champ d'activité. Cela pourrait entraîner des suggestions pour améliorer le soutien et les initiatives des organismes appuyant l'ergonomie au Canada.

**Risques possibles :**
Il n'existe aucun risque physique, affectif, social ou financier pour les participants prenant part à cette étude.

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**Confidentialité :**
Le devoir éthique de confidentialité consiste à protéger l'identité et les renseignements personnels des participants contre tout accès, utilisation ou divulgation non autorisés. Cela se fera par la collecte de données qui ne comprennent pas d'identifiant, tel que le nom du participant ou de son employeur, et en utilisant les données agrégées pour rendre compte des résultats du sondage.

**Anonymat :**
Le terme « anonymat » fait référence à la protection des caractéristiques permettant l'identification des participants (p. ex., le nom ou la description physique). Tous les efforts raisonnables seront faits pour assurer l'anonymat des participants. Ces derniers ne seront identifiés dans aucune publication sans avoir obtenu leur permission explicite.

De même, afin de préserver la confidentialité des informations fournies dans le sondage, aucune caractéristique permettant l'identification des participants ne sera donnée à la principale chercheuse ni au superviseur. Cela permettra de protéger l'anonymat des participants.

Lorsqu'un participant souhaite divulguer des informations personnelles (p. ex., son nom ou ses coordonnées) pour une raison quelconque, celles-ci doivent être transmises par correspondance privée auprès de la chercheuse principale au lieu de les inscrire dans le sondage.

**Enregistrement des données :**
Outre les résultats globaux du sondage, aucun autre type d'enregistrement ne sera effectué au cours de ce projet.

**Conservation des données :**
Les données électroniques recueillies dans le cadre de cette étude seront sauvegardées sur un disque dur protégé par un mot de passe dans les bureaux de la School of Human Kinetics and Recreation. Tous les documents papier ayant trait aux données seront aussi conservés au même endroit dans un classeur fermé à clé. Les seules personnes ayant accès aux données seront la chercheuse principale (Linda Sagmeister) et le superviseur (Scott MacKinnon). Les données seront conservées pendant cinq ans. Ensuite, les documents papier seront détruits par déchiquetage et les données sauvegardées seront supprimées. Les données ne se seront pas archivées.

Le sondage en ligne est hébergé sur le site d'hébergement Qualtrics, situé aux États-Unis. La *US Patriot Act* permet aux autorités américaines d'accéder aux données de fournisseurs de services Internet. Par conséquent, l'anonymat et la confidentialité ne peuvent être assurés. Si vous choisissez de participer à ce sondage, vous comprenez que vos réponses aux questions seront

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sauvegardées aux États-Unis et que l'accès aux données est possible. La politique de sécurité et confidentialité de ce site d'hébergement se trouve sur : www.qualtrics.com/privacy-statement/.

**Communication des résultats :**
Les résultats de cette étude seront publiés sous forme de communication dans le cadre de conférences et dans des articles de revue. Le mémoire de maîtrise sera mis à la disposition du public à la bibliothèque QEII. Les résultats de la collecte de données seront présentés uniquement sous forme agrégée ou condensée.

**Partage des résultats avec les participants :**
Les résultats de l'étude seront résumés dans un rapport envoyé à chacune des associations professionnelles ayant pris part au projet de recherche. Celles-ci auront le choix de distribuer ou d'afficher le rapport. Les participants qui souhaitent obtenir une copie des résultats de l'étude peuvent communiquer directement avec Linda Sagmeister (lsagmeister@mun.ca), Scott MacKinnon (smackinn@mun.ca) ou l'association ayant permis l'accès au sondage à partir de son site Internet.

**Questions :**
Il est possible de poser des questions en tout temps avant, pendant, ou après votre participation à ce projet de recherche. Si vous souhaitez obtenir de plus amples renseignements sur l'étude, veuillez contacter Linda Sagmeister, lsagmeister@mun.ca, ou son superviseur Scott MacKinnon, smackinn@mun.ca (tél. 709-864-6936).

La proposition de cette recherche a été examinée par le comité interdisciplinaire d'éthique en recherche chez l'humain et est jugée conforme à la politique sur l'éthique de la Memorial University of Newfoundland. Pour toute question d'ordre éthique concernant cette recherche (p. ex., la façon dont vous avez été traité ou vos droits à titre de participant), veuillez contacter le président du CIERH par courriel à l'adresse icehr@mun.ca ou par téléphone au 709-864-2861.

**Consentement :**
En répondant au présent sondage, vous reconnaissez que :

- Vous avez lu les informations sur le projet de recherche.
- Vous avez été informé que vous pouviez poser des questions sur cette étude et recevoir les réponses avant de poursuivre les autres étapes.
- Vous êtes satisfait des réponses obtenues à la suite de vos questions.
- Vous comprenez que l'étude porte sur ce que vous faites ou ferez.
- Vous comprenez que vous pouvez vous retirer de l'étude en fermant votre navigateur ou en quittant cette page sans donner de raison, et que cela n'aura aucune conséquence pour vous, soit maintenant ou plus tard.

4

- Accepter
- N'accepter pas

Q1.1 Thank you for agreeing to take part in this voluntary survey, which is a part of the focus of my work as a Master's candidate in Ergonomics, at the Memorial University of Newfoundland, Canada. This survey will take approximately 20 minutes of your time to complete, and a progress bar will inform you on how much of the survey you have completed. The purpose of this survey is to gather information on how practicing ergonomics professionals view and perceive ergonomics, and to gauge the degree of organizational support they receive at their workplace. Your participation in this survey will help to provide further insight for the Ergonomics/Human Factors community on how the field is perceived by its practitioners. This information may be used to help identify opportunities for employers of ergonomists to help to improve the strength of their professional services. For the purposes of this survey, the terms "Human Factors" and "Ergonomics" will be assumed to have the same meaning and application in the field. Although the data from this research project will be published and presented at conferences, the data will be reported in aggregate form, so that it will not be possible to identify individuals. Please do not put your name or other identifying information in the survey responses, so that it will not be possible to associate a name with any given set of responses. If at any time you feel that you would like to withdraw from participating, simply exit the survey and it will not have been "submitted". Your information will have been deleted.

Thank you for your time; it is greatly appreciated. Linda Sagmeister, MSc candidate Memorial University of Newfoundland(lsagmeister@mun.ca)

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Memorial University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@mun.ca or by telephone at 709-864-2861.

**Q1.2 Part I - Demographics**

Q1.3 What is your gender?

- Male
- Female
- Other

Q1.4 What is  your age?

- less than 20 years
- 21 - 35 years
- 36 - 50 years
- >50 years

Q1.5 Of the choices below, with what role do you most identify?

- Ergonomist
- Human Factors specialist
- Occupational Health Psychologist
- Occupational Therapist
- Physiotherapist
- Kinesiologist
- Safety Professional
- Industrial Hygienist

- Other Allied Health Professional (please describe) _____

Q1.6 What is your education? Please list any degrees, post graduate degrees.

Q50 Do you have a license or certification? Please mark all that apply.

- Canadian Certified Professional Ergonomist
- Certified Professional Ergonomist
- Licensed Occupational Therapist
- Licensed Physiotherapist
- Registered Kinesiologist
- Canadian Registered Safety Professional
- Certified Health and Safety Consultant
- Certified Industrial Hygienist
- Other (please describe) _____
- No license, registration or certification

Q1.7 Are you a member of any of the following professional associations? (Please check all that apply).

- Association of Canadian Ergonomists
- Canadian Association of Occupational Therapists
- Canadian Kinesiology Alliance
- Canadian Physiotherapy Association
- Canadian Registered Safety Professionals

- Canadian Registration Board of Occupational Hygienists
- Society for Occupational Health Psychology (SOHP)
- Canadian Society of Safety Engineering
- International Ergonomics Association affiliated society (please specify which society) _____
- Other professional Association: (please provide the association name ) _____
- None of the above

**Q2.1 Part II: Your Practice**

Q2.2 I practice ergonomics as a part of my regular job, (i.e. at least daily or in projects, such that at least 1/4 of my time in a year is spent practicing ergonomics).

- Yes
- No

Q52 How much of your work volume consists of practicing ergonomics?

- less than 50%
- 50% to 75%
- >75% to 100%

Q2.3 I have been practicing ergonomics as a part of my job for:

- Less than 5 years
- 5 - 10 years
- 11 - 15 years

- >15 years

Q2.4 In what location do you practice most?

- Outside Canada
- Alberta
- BC
- Saskatchewan
- Manitoba
- Quebec
- Ontario
- PEI
- New Brunswick
- Newfoundland/Labrador
- Nova Scotia
- Northwest Territories
- Nunavut
- Yukon Territories

Q2.5 In what setting do you primarily work?

- Self employed (Please describe your type of work) _____
- Government or related (municipality, university, school, hospital, provincial or federal)

- Private company (other than self employed) or "Ergonomics Service Provider", i.e. where ergonomics IS the primary service or mandate of the company.

- Private company (other than self employed) where ergonomics is NOT the primary service or mandate of the company, although it may be the mandate of your job within the company or of the company department in which you work.

- Other (please specify) _____

Q57 If working in a department within a company (where ergonomics is NOT the primary service of the company), or if working for Government, please specify the name of the Department in which you work. (e.g. Infrastructure Support, Customer Service)

**Q3.1 Part III: Resources for Your Practice**

Q53 Does your employer support access to professional or peer reviewed journals?

- Yes

- No

Q3.2 Do you use professional or peer reviewed journals (including Ergonomics journals) to obtain information that helps you in your work?

- Yes

- No

Q3.4 What prohibits you from referring to professional or peer reviewed journals in the course of your work?

- I do not have a need to use them

- Wasn't aware there are any in my field

- No time

- Other _____

Q54 Does your employer support your continued professional development? (other than access to professional or peer reviewed journals)

- Yes
- No

**Q4.1 Part IV: Ergonomics and Psychosocial Conditions: The following questions are about general workplace conditions and practices. Answers should reflect your opinion on workplaces in general, and NOT on your own specific workplace.**

Q4.3 Please indicate your agreement with the following statement for each of these conditions and practices:

"This workplace condition or practice is important to the safety and health of workers."

| | Strongly disagree | Disagree | Somewhat Disagree | Neither Agree nor Disagree | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| Sufficient staff for the | • | • | • | • | • | • | • |
| Reasonable work pace | • | • | • | • | • | • | • |
| Appropriate emotional | • | • | • | • | • | • | • |
| Sufficient influence | • | • | • | • | • | • | • |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sufficient possibilities | • | • | • | • | • | • | • |
| Recognizable meaning of | • | • | • | • | • | • | • |
| Commitment to the | • | • | • | • | • | • | • |
| Trust regarding | • | • | • | • | • | • | • |
| Sufficient justice and | • | • | • | • | • | • | • |
| Predictability | • | • | • | • | • | • | • |
| Appropriate recognition | • | • | • | • | • | • | • |
| Role clarity | • | • | • | • | • | • | • |
| Good quality of leadership | • | • | • | • | • | • | • |
| Social support from | • | • | • | • | • | • | • |
| Sufficient job | • | • | • | • | • | • | • |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Work-family balance | • | • | • | • | • | • | • |
| No sexual harassment | • | • | • | • | • | • | • |
| No threats of violence | • | • | • | • | • | • | • |
| No physical violence | • | • | • | • | • | • | • |
| No bullying | • | • | • | • | • | • | • |

Q4.5 Do you believe that ergonomics can be applied in order to control psychosocial hazards in the workplace independently of musculoskeletal injury prevention issues?

- Yes (please explain) _____
- No (please explain) _____

Q4.6 Do you believe that there is any research done in the ergonomics field on psychosocial hazards, which is independent of the issue of musculoskeletal injuries?

- Yes
- No
- I do not know
- Please explain _____

Q4.7 Ergonomics deals primarily with musculoskeletal injuries and how to prevent them.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree
- Please explain _____

Q4.8 Psychosocial hazards in the workplace can not be addressed using ergonomics, EXCEPT through the provision of an appropriate work area that fits the physical abilities of the worker.

- Strongly Disagree
- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree
- Please explain _____

Q4.9 I associate the practice of ergonomics with the management of psychosocial hazards in the workplace.

- Strongly Disagree

- Disagree
- Neither Agree nor Disagree
- Agree
- Strongly Agree
- Please explain _____

**Q5.1 Part V: Perspective on Your Profession and Organization.**

**This section asks about your perspective on your current profession and organization. Consider the profession and the organization that you spend the most time working in/for when answering these questions.**

Q5.3 Please mark the appropriate response for each question.

| | Strongly Disagree | Disagree | Somewhat Disagree | Neither Agree nor Disagree | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| My profession is important | • | • | • | • | • | • | • |
| I regret having entered this profession | • | • | • | • | • | • | • |
| I am proud to be in this profession | • | • | • | • | • | • | • |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| I dislike being in this profession | • | • | • | • | • | • | • |
| I do not identify with this profession | • | • | • | • | • | • | • |
| I am enthusiastic about my profession | • | • | • | • | • | • | • |

Q5.4 Please mark the appropriate response for each question.

| | Strongly Disagree | Disagree | Somewhat Disagree | Neither Agree nor Disagree | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| I have put too much into this profession to consider changing now | • | • | • | • | • | • | • |
| Changing professions now would be difficult for me to do | • | • | • | • | • | • | • |
| Too much of my life | • | • | • | • | • | • | • |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| would be disrupted if I were to change my profession | | | | | | | |
| It would be costly for me to change my profession now | • | • | • | • | • | • | • |
| There are no pressures to keep me from changing professions | • | • | • | • | • | • | • |
| Changing professions now would require considerable personal sacrifice | • | • | • | • | • | • | • |

Q5.5 Please mark the appropriate response for each question.

| | Strongly Disagree | Disagree | Disagree Somewhat | Neither Disagree nor Agree | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| I believe people who have been trained in a profession have a responsibility to say in that profession for a reasonable period of time | • | • | • | • | • | • | • |
| I do not feel any obligation to remain in my current profession | • | • | • | • | • | • | • |
| I feel a responsibility to my profession to continue in it | • | • | • | • | • | • | • |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Even if it were to my advantage, I do not feel that it would be right to leave my profession now. | • | • | • | • | • | • | • |
| I would feel guilty if I left my profession | • | • | • | • | • | • | • |
| I am in this profession because of a sense of loyalty to it. | • | • | • | • | • | • | • |

Q5.6 Please mark the appropriate response for each question.

| | Strongly Disagree | Disagree | Somewhat Disagree | Neither Agree nor Disagree | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| I would be very happy to spend the rest of my career with this organization | • | • | • | • | • | • | • |
| I really feel as if this organization's problems are my own. | • | • | • | • | • | • | • |
| I do not feel a strong sense of "belonging" to my organization | • | • | • | • | • | • | • |
| I do not feel "emotionally attached" to this organization | • | • | • | • | • | • | • |
| I do not fee like "part of the family" at my organization | • | • | • | • | • | • | • |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| This organization has a great deal of personal meaning for | • | • | • | • | • | • | • |

Q5.7 Please mark the appropriate response for each question.

| | Strongly Disagree | Disagree | Somewhat Disagree | Neither Agree nor Disagree | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| Right now, staying with my organization is a matter of necessity as much as desire | • | • | • | • | • | • | • |
| It would be very hard for me to leave my organization even if I wanted to | • | • | • | • | • | • | • |
| Too much of my life would be disrupted if I decided to leave my organization now | • | • | • | • | • | • | • |
| I feel that I have too few options to consider leaving this organization | • | • | • | • | • | • | • |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| If I had not already put so much of myself into this organization, I might consider working elsewhere | • | • | • | • | • | • | • |
| One of the few negative consequences of leaving this organization would be the scarcity of available alternatives | • | • | • | • | • | • | • |

Q5.8 Please mark the appropriate response for each question.

| | Strongly Disagree | Disagree | Somewhat Disagree | Neither Agree nor Disagree | Somewhat Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| I do not feel any obligation to remain with my current employer | • | • | • | • | • | • | • |
| Even if it were to my advantage, I | • | • | • | • | • | • | • |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| do not believe it would be right to leave my organization now. | | | | | | | |
| I would feel guilty if I left my organization now | • | • | • | • | • | • | • |
| this organization deserves my loyalty | • | • | • | • | • | • | • |
| I would not leave my organization right now because I have a sense of obligation to the people in it. | • | • | • | • | • | • | • |
| I owe a great deal to my organization | • | • | • | • | • | • | • |

## Appendix B: Participation of Professional Associations

***The Association of Canadian Ergonomists (ACE)*** provided access to their membership via electronic distribution performed by their executive director directly to those members who had provided consent to the Association to contact them by email.

***The Canadian Association of Occupational Therapists (CAOT)*** and the ***Canadian Physiotherapy Association (CPA)*** each agreed to allow access to membership through electronic posting of the survey invitation in their membership electronic newsletters, which are distributed regularly to their membership.

Occupational Health Psychologists in Canada were contacted through posting the invitation and appropriate information on the ***Society for Occupational Health Psychology's (SOHP)*** LinkedIn page. In addition, personal disbursement to Canadian Occupational Health Psychologists with the assistance of Dr. Kevin Kelloway, Canada Research Chair in Occupational Health Psychology at Saint Mary's University, Halifax, Nova Scotia.

Industrial Hygienists in Atlantic Canada were contacted with the permission and assistance of the ***Atlantic Council of Occupational Hygiene*** (part of the American Industrial Hygiene Association, (AIHA)). This organization was approached to distribute the survey electronically to its members, which consists of Occupational Hygienists in Atlantic Canada. The organization's representative provided the survey link to members via email.

The survey was distributed to Occupational Health and Safety professionals electronically, via the "LinkedIn" page hosted by the ***Board of Canadian Registered Safety Professionals (BCRSP)*** and that of the ***Canadian Society of Safety Engineering (CSSE)***. Permission had been obtained both from BCRSP and the CSSE to post the link to their sites.

***The Ontario Kinesiology Association (OKA)*** and the ***BC Association of Kinesiologists (BCAK)*** posted the link on their websites on behalf of the author.

Industrial Engineers were contacted for their input via their professional association; the ***Institute for Industrial Engineers (IIE)***. The invitation to participate in the survey was provided by the Vice President of the Institute for Industrial Engineers (Canada), to the chair people of two Canadian chapters (Toronto and Atlantic Canada). Each of these people was asked to provide the survey link to their members via personal email.

## Appendix C Statistical Analysis: Defining "aware" variables

### Numeric "awareness" (based on Q4.7-Q4.9):

"Awareness" is defined as a respondent understanding that ergonomics practices can control psychosocial hazards in the workplace independently of the MSI trigger to act. To attain a numeric measure of "awareness", the following 5-point Likert-type questions were scored on a scale from -2 to +2, with lower scores indicating a lack of understanding/awareness.

Q4.7: Ergonomics deals primarily with musculoskeletal injuries and how to prevent them. This question is scored from +2 (Strongly Disagree) to -2 (Strongly Agree).

Q4.8: Psychosocial hazards in the workplace cannot be addressed using ergonomics, EXCEPT through the provision of an appropriate work area that fits the physical abilities of the worker. This question is scored from +2 (Strongly Disagree) to -2 (Strongly Agree).

Q4.9: I associate the practice of ergonomics with the management of psychosocial hazards in the workplace. This question is scored from -2 (Strongly Disagree) to +2 (Strongly Agree).

In the event that a respondent chose two categories for a single question, the average of those selections was calculated. The average of responses to the three questions became each respondent's numeric "awareness" score on a scale from -2 to +2,

with lower scores indicating a lack of understanding/awareness that ergonomics practices can control psychosocial hazards in the workplace.

***Controlling Numeric "awareness" for Correlations with Demographics: Age, Gender, Years of Experience; Work Volume in Ergonomics***

The point-biserial correlation between gender and numeric "awareness" was calculated and found to be non-significant ($\rho$ = -.080; $p$ = .484).

Kendall's and Spearman's correlations were calculated between numeric "awareness" and the multi-category demographic variables of Age, Years of Experience and Work Volume in Ergonomics. Both are non-parametric calculations, so the normality of the numeric "awareness" variable is not required. Kendall's tau-b p-values are more accurate for small sample sizes, while Spearman's is more widely used; both lead to the same conclusions. Work Volume in Ergonomics is not significantly correlated with numeric "awareness" (*Kendall's* $\tau_b$ = .065, $p$ = .476; *Spearman's* $\rho$ = .088, $p$ = .440). Age (*Kendall's* $\tau_b$ = .205, $p$ = .025; *Spearman's* $\rho$ = .251, $p$ = .025), and Years of Experience (*Kendall's* $\tau_b$ = .344, $p < .001$; *Spearman's* $\rho$ = .421, $p < .001$), were both significantly positively correlated with numeric "awareness". Of course, Age and Years of Experience were very significantly correlated (*Kendall's* $\tau_b$ = .604, $p < .001$; *Spearman's* $\rho$ = .676, $p < .001$).

A multiple regression was run using numeric "awareness" as the dependent variable in order to account for variability attributable to the demographic variables used

as independent variables. The residuals from the regression analysis then serve as highly correlated "proxies" for numeric "awareness". Further analysis referencing numeric "awareness" controlled for demographic variables was performed on the regression residuals. These analyses benefit from the improved normality of the residuals (controlled numeric "awareness"), and are better able to distinguish differences in "awareness" related to other variables of interest. As expected from the high correlations involving "awareness", Age and Years of Experience - Years of Experience is the most significant predictor of numeric "awareness", and their relationship warrants an independent investigation.

The independent variable for regression (A_mean) was found to be slightly negatively skewed ($z_{skew}$ = -0.542) and platykurtic (i.e. flat, $z_{kurt}$ = -1.039) relative to a normal distribution, but neither value was significant (Figure C1). The Kolomogorov-Smirnov normality test suggests that numeric "awareness" is only approximately normal ($D_{(79)}$ = .096, $p$ = .067), but sufficiently so to serve as the independent variable in regression (Table C1). Once controlled for relationships with the demographic variables, numeric "awareness" (A_control) exhibits a normal distribution ($D_{(79)}$ = .070, $p$ > .200) with neither discernable skewness ($z_{skew}$ = 0.303) nor kurtosis ($z_{kurt}$ = -0.430) (Figure C2), making it suitable for subsequent ANOVA analysis.

The multiple regression model using the four demographic variables as predictors accounted for a respectable 15% of the variance in numeric "awareness" ($R^2$ = .193, $R_{adj}^2$ = .150) (Table C2) and is a significant fit of the data ($F_{(4, 74)}$ = 4.428, $MSE$ = 0.618,

$p$ = .003) Table C3. By far the most significant association was found with Years of Experience ($\beta$ = .465, $SE$ = .108, $t$ = 3.184, $p$ = .002), suggesting that a one standard deviation increase in Years of Experience relates to a 0.465 standard deviation increase in numeric "awareness" (Table C4).

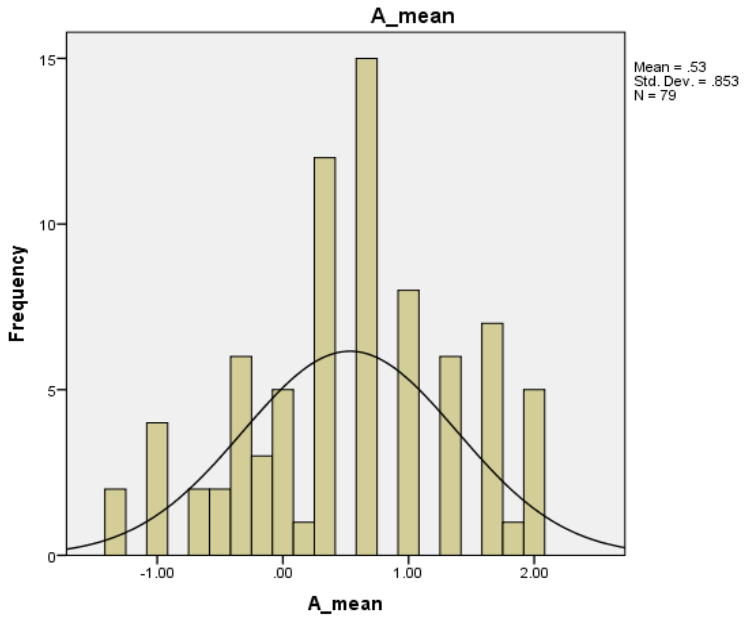


**Figure C1: numeric "awareness" distribution before controlling for demographic variables.**

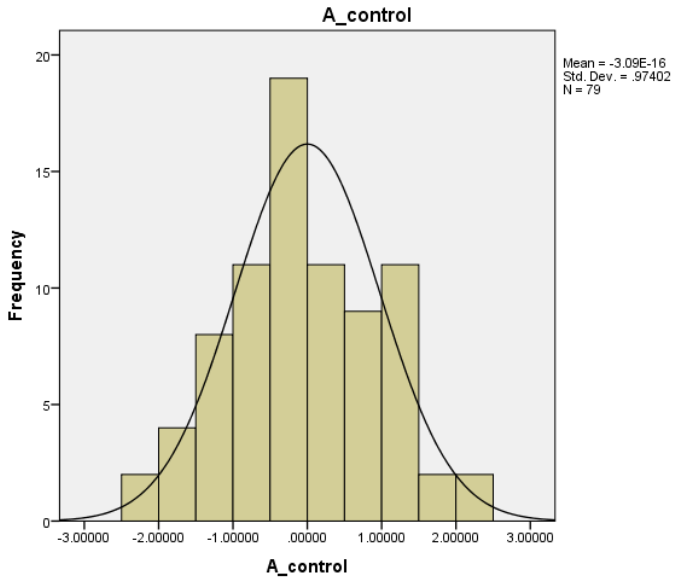


**Figure C2: numeric "awareness" distribution after controlling for demographic variables.**

Table C1:

Tests of Normality for numeric "awareness"

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| A_mean | .096 | 79 | .067 | .970 | 79 | .056 |
| A_control | .070 | 79 | .200* | .990 | 79 | .778 |

* This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table C2

Model Summary[b]

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .439[a] | .193 | .150 | .78619 |

a. Predictors: (Constant), YoExp, Gender, WV_Ergo, Age
b. Dependent Variable: A_mean

Table C3
ANOVA[b]

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 10.948 | 4 | 2.737 | 4.428 | .003[a] |
| | Residual | 45.739 | 74 | .618 | | |
| | Total | 56.688 | 78 | | | |

Table C4
Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -.370 | .323 | | -1.146 | .255 |
| | Gender | -.227 | .188 | -.128 | -1.206 | .232 |
| | WV_Ergo | .049 | .105 | .050 | .466 | .643 |
| | Age | -.068 | .158 | -.063 | -.431 | .667 |
| | YoExp | .343 | .108 | .465 | 3.184 | .002 |

**Numeric "awareness" related to Years of Experience**

Prior to an ANOVA analysis of numeric "awareness" across levels of Years of Experience, Levene's test for the homogeneity of variance was performed ($F_{(3, 75)} = 1.471$, $p = .229$). The result indicates that numeric "awareness" has approximately equal variance within each category of Years of Experience. In the one-way ANOVA, Years of Experience had a significant, and large effect on numeric "awareness" ($F_{(3, 75)} = 6.830$, $p < .001$, $\omega = .426$). In fact, a somewhat significant and moderate quadratic effect is present ($F_{(1, 75)} = 3.320$, $p = .076$, $\omega = .152$) (Table C5).

A planned contrast revealed that average "awareness" for those with 10 or fewer years of experience (YoExp = 1,2) is significantly lower than average "awareness" for those with over 10 years of experience (YoExp = 3,4), with a moderate effect size ($t_{(75)} = -2.976$, $p = .002$ (1-tailed), $r = .325$). On average, those with less experience scored 0.58 units lower on the numeric "awareness" measure as demonstrated in Figure C3.

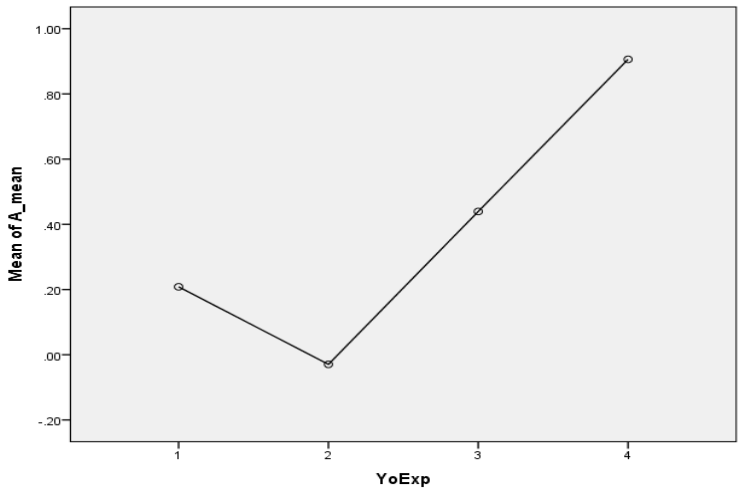


**Figure C3: numeric "awareness" compared to Years of Experience**

To determine significant group differences where sample sizes are somewhat different in each experience group, post-hoc analyses were performed using Gabriels's procedure and Hochberg's GT2 options in SPSS (Field, 2013). These analyses confirm that experience group 4 is significantly different from groups 1 and 2, but not experience group 3. They also confirm that group 1 is not significantly different from group 2 or group 3.

Table C5
ANOVA (numeric "awareness" (A_mean) x Years of Experience)

| | | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|---|
| Between Groups | (Combined) | | 12.164 | 3 | 4.055 | 6.830 | .000 |
| | Linear Term | Unweighted | 5.805 | 1 | 5.805 | 9.779 | .003 |
| | | Weighted | 9.790 | 1 | 9.790 | 16.491 | .000 |
| | | Deviation | 2.374 | 2 | 1.187 | 1.999 | .143 |
| | Quadratic Term | Unweighted | 1.918 | 1 | 1.918 | 3.230 | .076 |
| | | Weighted | 2.029 | 1 | 2.029 | 3.418 | .068 |
| | | Deviation | .345 | 1 | .345 | .581 | .448 |
| Within Groups | | | 44.524 | 75 | .594 | | |
| Total | | | 56.688 | 78 | | | |

Table C6
Contrast Tests

| | | Contrast | Value of Contrast | Std. Error | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| A_mean | Assume equal variances | 1 | -.5832 | .19595 | -2.976 | 75 | .004 |
| | Does not assume equal variances | 1 | -.5832 | .19625 | -2.972 | 39.130 | .005 |

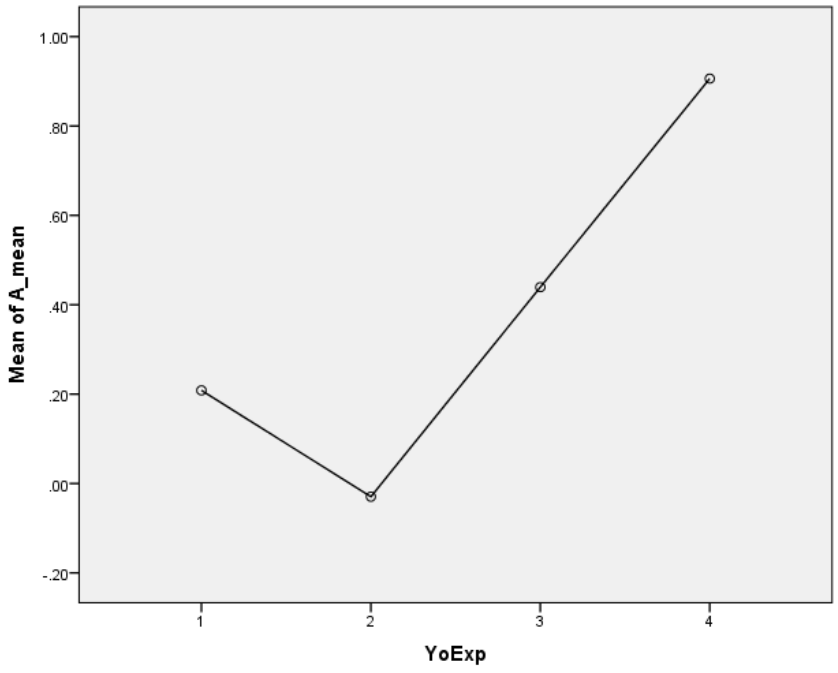


**Figure C3: numeric "awareness" compared to Years of Experience**

**3-Category "awareness" (based on Q4.5&Q4.6)**

A categorical measure of "awareness" was determined via responses to the following questions.

Q4.5: Do you believe that ergonomics can be applied in order to control psychosocial hazards... This question had possible answers of YES and NO.

Q4.6: Do you believe that there is any research done in the ergonomics field on psychosocial hazards… This question had possible answers of YES and NO and I DON'T KNOW.

A respondent was classified as: Highly Aware (Hi: coded as category 1) if they answered YES to both questions; Mid-Aware (Mid: coded as category 2) if they answered YES to only one of the questions; and Low-Aware (Lo: coded as category 3) otherwise (i.e., answering NO to Q4.5 and NO or I DON'T KNOW to Q4.6). Note that a negative correlation with this 3-category "awareness" variable indicates that as the related variable "increased" (numerically or categorically), the respondent is – on average – classified as more understanding/aware that ergonomic practices can mitigate psycho-social hazards in the workplace.

**Is Numeric "awareness" (based on Q4.7-Q4.9) agreeing with the 3-category "awareness" (based on Q4.5&Q4.6)?**

Table C7 demonstrates that average numeric "awareness" (A_mean) decreases as the 3-category "awareness" variable moves from "Highly Aware" to "Low-Aware". This decreasing trend is evident in the averages of each of the questions that define numeric "awareness".

Table C7
Numeric "awareness" compared to 3-category "awareness"

| Count | 3-cat "awareness" | A_mean | Q4.7 mean | Q4.8 mean | Q4.9 mean |
|---|---|---|---|---|---|
| 41 | Hi | 0.890 | 0.232 | 1.268 | 1.171 |
| 30 | Mid | 0.244 | -0.200 | 0.750 | 0.183 |
| 8 | Lo | -0.208 | -0.688 | 0.313 | -0.250 |

The average response for Q4.7 is somewhat lower (in all awareness categories) than responses to Q4.8 and Q4.9. This may reflect some confusion interpreting the meaning of Q4.7. It is likely that this question was misinterpreted, since the intent could be understood to mean that ergonomics is used to prevent MSIs *in reality* as opposed to *in*

*theory,* in which case many EPs would have "agreed" since it was clear in the comments that there are struggles to practice ergonomics for reasons other than MSI in most work settings.

Kendall's and Spearman's correlations were calculated between numeric "awareness" and the 3-category "awareness" variable. Both are non-parametric calculations, so the normality of the numeric "awareness" variable is not required. Kendall's tau-b p-values are more accurate for small sample sizes, while Spearman's is more widely used; both lead to the same conclusions. The two variables measuring awareness were found to be significantly negatively and moderately correlated (*Kendall's* $\tau_b$ = -.370, $p < .001$; *Spearman's* $\rho$ = -.437, $p < .001$), suggesting a strong tendency for numeric "awareness" to decrease with "lower" 3-category "awareness" classification. Similarly significant correlations remain after numeric "awareness" is controlled for the demographic variables (*Kendall's* $\tau_b$ = -.305, $p = .001$; *Spearman's* $\rho$ = -.378, $p = .001$). The correspondence between the two "awareness" variables is further supported by significant results from non-parametric Kruskal-Wallace, median and Jonckheere-Terpstra tests performed in SPSS.

**4-Category "awareness" (based on 3-cat & numeric "awareness")**

In an effort to combine the information collected in the five "awareness" survey questions, a 4-category "awareness" variable was created by subdividing each of the 3-category groups (Hi, Mid, Lo) based on the respondent's numeric "awareness" score. Table C8 describes how each respondent's "awareness" was re-classified as either: Very

High (v.hi, coded as category 1), Moderately High (m.hi, coded as category 2), Moderately Low (m.lo, coded as category 3), or Very Low (v.lo, coded as category 4). The break-points of numeric "awareness" that determined the respondent's new classification in the 4-category "awareness" variable arose naturally in the dataset, and achieved somewhat better balance in the sample size of each category. The values of 1 and -1 are also natural divisions in the 5-point integer scale of numeric "awareness" from -2 to +2. Table C9 summarizes average numeric "awareness" across the new 4-category "awareness" variable.

Note that the 20 respondents newly classified as Very High "awareness" scored highly (on average) to Q4.7, and their average responses to all three questions are very comparable. On the other hand, those not classified as Very High "awareness" tended to score quite a bit lower on Q4.7 than on Q4.8 and Q4.9. This result suggests those that are not Very High "awareness" had a more difficult time interpreting Q4.7; or perhaps that the most "aware" individuals were best able to decipher Q4.7. In subsequent analysis, there was very little distinction between the Moderately High and Moderately Low categories of "awareness" with respect to relationships with other variables of interest.

Table C8
Reclassification of "awareness" responses across types of measures

| **# records moved** | **From (3-cat)** | **To (4-cat)** | **Q4.5** | **Q4.6** | **Numeric "awareness"** |
|---|---|---|---|---|---|
| 20 | Hi | v.hi | yes | Yes | >= 1 |
| 21 | Hi | m.hi | yes | Yes | < 1 |
| 6 | Mid | m.hi | Else | | >= 1 |
| 21 | Mid | m.lo | Else | | > -1, but < 1 |
| 3 | Mid | v.lo | Else | | <= -1 |
| 2 | Lo | m.lo | no | not yes | >= 0.66 |
| 6 | Lo | v.lo | no | not yes | < 0.66 |

Table C9
Average numeric “awareness” across the new 4-category “awareness” variable.

| **Count** | **4-cat “awareness”** | **A_mean** | **Q4.7 mean** | **Q4.8 mean** | **Q4.9 mean** |
|---|---|---|---|---|---|
| 20 | v.hi | 1.525 | 1.425 | 1.650 | 1.500 |
| 27 | m.hi | 0.494 | -0.481 | 1.074 | 0.889 |
| 23 | m.lo | 0.232 | -0.261 | 0.761 | 0.196 |
| 9 | v.lo | -0.778 | -1.278 | -0.278 | -0.778 |

## Appendix D: Guarding Minds @ Work, PF1- PF13 (2012)

### PF1: Psychological Support

A work environment where coworkers and supervisors are supportive of employees' psychological and mental health concerns, and respond appropriately as needed.

### PF2: Organizational Culture

A work environment characterized by trust, honesty and fairness.

### PF3: Clear Leadership & Expectations

A work environment where there is effective leadership and support that helps employees know what they need to do, how their work contributes to the organization, and whether there are impending changes.

### PF4: Civility & Respect

A work environment where employees are respectful and considerate in their interactions with one another, as well as with customers, clients and the public.

### PF5: Psychological Competencies & Requirements

A work environment where there is a good fit between employees' interpersonal and emotional competencies and the requirements of the position they hold.

**PF6: Growth & Development**

A work environment where employees receive encouragement and support in the development of their interpersonal, emotional and job skills.

**PF7: Recognition & Reward**

A work environment where there is appropriate acknowledgement and appreciation of employees' efforts in a fair and timely manner.

**PF8: Involvement & Influence**

A work environment where employees are included in discussions about how their work is done and how important decisions are made.

**PF9: Workload Management**

A work environment where tasks and responsibilities can be accomplished successfully within the time available.

**PF10: Engagement**

A work environment where employees feel connected to their work and are motivated to do their job well.

**PF11: Balance**

A work environment where there is recognition of the need for balance between the demands of work, family and personal life.

**PF12: Psychological Protection**

A work environment where employees' psychological safety is ensured.

**PF13: Protection of Physical Safety**

A work environment where management takes appropriate action to protect the physical safety of employees.

## Appendix E: Ergonomics principles according to ISO Standards 26800 and 6385

### ISO 26800:2011(E) Ergonomics — General approach, principles and concepts

Ergonomics principles according to this Standard:

"All designable components of a system, product or service are fitted to the characteristics of the intended users, operators or workers, rather than selecting and/or adapting humans to fit the system, product or service" (p. 5).

"Design shall take full account of the nature of the task and its implications for the human" (p. 6).

"The physical, organizational, social and legal environments in which a system, product, service or facility is intended to be used shall be identified and described, and their range defined" (p. 6).

"Evaluation of the ergonomic design outcome of any system, product or service shall be based on established ergonomics criteria, regardless of whether or not it was designed following an ergonomics-based design process" (p. 7)

### ISO 6385:2004(E) Ergonomic principles in the design of work systems

Ergonomics principles according to this Standard:

"In the design process, the major interactions between one or more people and the components of the work system, such as tasks, equipment, workspace and environment, shall be considered" (p. 3).

"Ergonomics shall be used in a preventive function by being employed from the beginning rather than being used to solve problems after the design of the work system is complete. However, it can be successfully employed in the redesign of an existing, unsatisfactory work system" (p. 3).

"Workers shall be involved in and should participate in the design of work systems during the process in an effective and efficient manner" (p. 3).