AN INVESTIGATION INTO TRAINING, EVALUATION, AND APPLICATION OF THE
PHYSICAL DEMANDS DESCRIPTION TO DOCUMENT PARAMEDIC WORK

by

Brendan Michael Coffey

A thesis submitted to the School of Kinesiology and Health Studies

In conformity with the requirements for

The degree of Master of Science

Queen’s University

Kingston, Ontario, Canada

(September, 2014)

Copyright ©Brendan Michael Coffey, 2014
Abstract

Every job requires a worker to complete a subset of physical demands. These physical demands are classified into different elements (e.g., lifting, pushing, pulling), each with requisite measurement characteristics (e.g., frequency, duration, weight). Understanding the physical demands is important when making job-related decisions such as developing job descriptions, adjudicating injury claims, and effectively facilitating return-to-work scenarios. As these decisions are made by professionals both internal to a workplace (e.g., managers, human resources, engineers) and external (e.g., physicians, insurance providers); physical demands information must be objective, easily understandable, and accurate. A Physical Demands Description (PDD) is the document that summarizes all physical demands of a job, as characterized following periods of job observation interspersed with physical demands measurements.

There were two main purposes of this research, 1) to study the effectiveness of PDD training on trainee’s ability to accurately identify and measure physical demand elements, and 2) to characterize the physical demands of paramedic work, by training paramedics to identify physical demand elements. First, PDD training was delivered to ten university students who then applied their training to perform condensed PDDs using three different job simulation examples. Participants accurately identified physical demand elements with a success rate of 80%, but failed to accurately measure aspects of those elements within a 10% margin of error relative to the criterion established by a team of subject matter experts. Implementing these findings, a participatory approach was taken to document the physical demands of paramedics by training paramedics to identify (not measure) the physical demands of their colleagues. Fourteen paramedics from seven services across Canada received PDD training to identify the physical
demands of their work. They documented demands during two separate full-shift ride-outs, acting as an observer. The most physically demanding aspects of paramedic work, as identified by paramedics, were stretcher loading and unloading (25.6% of respondents), carrying equipment (19.5%), and pushing and pulling the stretcher (13.4%). When considering differences in task frequency between service population areas, high-populated services loaded and unloaded an empty stretcher and handled medication bags more frequently than low-populated services. These data contribute to the Canadian paramedic community by characterizing the work of paramedics, useful in developing a physical abilities pre-hire test to ensure candidates match the physical demands of the occupation.
Statement of Co-Authorship

This thesis represents the work of Master’s Candidate Brendan Coffey in collaboration with multiple researchers. Brendan Coffey was the primary author of all chapters in the thesis, where thesis supervisor, Steven Fischer PhD, provided thoughts and suggested revisions where appropriate. Both manuscript-style chapters will be submitted to the Journal of Applied Ergonomics, and each has a separate authors list, as indicated below. The order of authors are listed as they appear on both manuscripts.

Chapter 3: Evaluating the ability of recently trained novices to identify and quantify physical demand elements in multiple job simulations: A pilot study.

1) Mr. Brendan Coffey – Contributed to development of the PDD Handbook and workshop, delivered PDD workshop to participants, facilitated data collection, conducted data and statistical analysis, interpreted findings, and was the principle author of the manuscript.

2) Mr. Curtis VanderGriendt – Contributed to development of the PDD Handbook and workshop, and provided comments and feedback to help improve the manuscript.

3) Dr. Steven Fischer – Contributed to development of the PDD Handbook and workshop, assisted in PDD workshop delivery, interpretation of findings, and provided comments and feedback to help improve the manuscript.

Chapter 4: A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work.

1) Mr. Brendan Coffey – Contributed to development of PDD workshop, contributed to development of data collection booklet, delivered PDD workshop to participants at each
site, compiled raw data from each data collection booklet into aggregate data for statistical analysis, performed the statistical analysis, interpreted findings, and was the principle author of the manuscript.

2) Dr. Renee MacPhee – Contributed to the recruitment and organization of paramedic service involvement, contributed to the development of the data collection booklet, assisted in delivering the PDD workshop, and provided comments and feedback to help improve the manuscript.

3) Mr. Doug Socha – Organized paramedic service involvement, and provided comments and feedback to help improve the manuscript. As the Hastings-Quinte Paramedic Services Chief, Mr. Socha also provided advice and context as a paramedic subject matter expert.

4) Dr. Steven Fischer – Contributed to organization of paramedic service involvement, contributed to the development of the data collection booklet, assisted in delivering the PDD workshop, aided in interpreting findings, and provided comments and feedback to help improve the manuscript.
Acknowledgements

I would like to express my appreciation to the following people who inspired and supported me throughout my graduate studies and helped make this thesis a possibility. First and foremost I would like to express my sincerest gratitude to my supervisor Dr. Steven Fischer for his guidance, patience, and enthusiasm over the past two years. Under his supervision our research has covered thousands of kilometers, several airports, buffets, countless Subways and Starbucks detours, ambulances (not as a patient), as well as making me an honorary military helicopter pilot along the way. These experiences have proved tremendously valuable in acquiring skills and knowledge tailored towards a profession in ergonomics and I have Steve to thank for a number of direct and indirect lessons learned along the way.

Drs. Joan Stevenson and Pat Costigan were instrumental in making me a well-rounded member of the Biomechanics and Ergonomics Laboratory. They instructed my first graduate level courses and challenged me to think critically and propose robust research methodologies, two aspects that assisted greatly in the development of this document. My thesis committee – Drs. Pat Costigan, Kathryn Sinden, and Ryan Graham – who encouraged me to view my work from a different perspective to help strengthen the presentation of findings and their implications.

My classmates, labmates, and QECP colleagues were great sources of comradery and help when needed. From marking undergraduate exams, to data collection, to bouncing ideas of one another, they made the lab a positive and enjoyable environment. I have to also acknowledge my friends – those in Kingston, and those out of town in Toronto or at home in Niagara. While they undoubtedly helped delay the completion of this thesis at times by beckoning me to join on weekend excursions and/or weeknight marathons of The Wire and Breaking Bad, their friendship allowed me to balance my workload and maintain my sanity at times.

To my family – Mom, Dad, Jon, and Dylan – for all their love and support from afar. Their comfort and encouragement made me look forward to spending time at home on holidays in a whole new light. And finally to my girlfriend Jenny for sharing the ups and downs of this experience with me. Through her love and encouragement she often helped to remind me why I started this degree in the first place when things became overbearing. I’m sure she learned much more about ergonomics and biomechanics than she ever bargained for.
# Table of Contents

Abstract .................................................................................................................................................. ii

Statement of Co-Authorship .................................................................................................................. iv

Acknowledgements ................................................................................................................................... vi

List of Figures ......................................................................................................................................... xi

List of Tables ......................................................................................................................................... xiii

Chapter 1 - Introduction ......................................................................................................................... 1
  1.1. General Overview .......................................................................................................................... 1
  1.2. Purpose of Thesis .......................................................................................................................... 2
  1.3. Objectives of Thesis ...................................................................................................................... 3
  1.4. Thesis Organization ....................................................................................................................... 3
  1.5. References ...................................................................................................................................... 5

Chapter 2 - Literature Review ............................................................................................................... 6
  2.1. WMSDs – An Overview ................................................................................................................. 6
  2.2. WMSD Risk Factors ...................................................................................................................... 6
  2.3. Ergonomics as a Means to Prevent WMSD .................................................................................. 8
  2.4. A Paramedic’s Job Description ..................................................................................................... 8
  2.5. WMSDs and Paramedics .............................................................................................................. 9
  2.6. Physical Demands of Paramedic Lifting Tasks: Biomechanical and Physiological Stressors ....... 11
  2.7. Non-Physical Demands of Paramedics: Stress and Fatigue ....................................................... 13
  2.8. Human Factors Issues Regarding Ambulance Interior ............................................................... 15
  2.9. Previous Interventions – What Has Been Done? ......................................................................... 17
  2.10. Future Interventions – What Else Can Be Done? ....................................................................... 19
  2.11. Physical Capacity of Paramedics ............................................................................................... 20
  2.12. Physical Demands, Functional Capacity and Bona Fide Occupational Requirements .................. 21
  2.13. Characterising the Physical Demands of a Workplace: The First Step towards Developing a Pre-Hire Physical Abilities Test ......................................................................................... 23
  2.14. The Need to Develop a Paramedic-Specific Physical Demands Description .............................. 24
2.15. Knowledge Gaps Regarding the Physical Demands Description ........................................ 25
2.16. Introducing Workplace Ergonomics - “Novice Observers” ........................................ 26
2.17. Implementing a Trained Novice Observer Approach with Paramedics ....................... 28
2.18. References .................................................................................................................. 30

Chapter 3 - Evaluating the ability of recently trained novices to identify and quantify physical demands elements in multiple job simulations: A pilot study ................................................................. 40

Abstract ............................................................................................................................... 41

3.1. Introduction .................................................................................................................. 42
3.2. Methods ....................................................................................................................... 45
  3.2.1. Participants .............................................................................................................. 45
  3.2.2. Developing a Physical Demands Data Training Resource ..................................... 45
  3.2.3. Revising the PDD Handbook .............................................................................. 45
  3.2.4. Developing the PDD Workshop ........................................................................... 46
  3.2.5. Physical Demand Element Identification Task .................................................... 49
  3.2.6. Physical Demand Element Quantification ............................................................. 49
  3.2.7. Data Analysis ....................................................................................................... 50
  3.2.8. Statistical Analysis: ............................................................................................. 52

3.3. Results ......................................................................................................................... 52
  3.3.1. Physical Demand Element Identification ............................................................... 52
  3.3.2. Physical Demand Element Quantification ............................................................... 54
    3.3.2.1. Lift/Lower ........................................................................................................ 55
    3.3.2.2. Push ................................................................................................................ 56
    3.3.2.3. Grip ................................................................................................................ 57
    3.3.2.4. Pull .................................................................................................................. 57
    3.3.2.5. Walk .............................................................................................................. 58

3.4. Discussion ................................................................................................................... 59
  3.4.1. Physical Demand Element Identification ............................................................... 59
  3.4.2. Physical Demand Element Quantification ............................................................... 60
  3.4.3. Practical Implications ............................................................................................ 62
Chapter 4 - A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work

Abstract

4.1. Introduction

4.2. Methods

4.2.1. Participants:

4.2.2. Developing the Participatory Ergonomics PDD Training Model

4.2.3. Research Design

4.2.4. Data Analysis:

4.2.5. Statistical Analysis:

4.3. Results

4.3.1. Descriptive Statistics: Time spent on call and patient demographics

4.3.2. Physical Demands from Seven Paramedic Services Selected from Across Canada:

4.3.3. Most Physically Demanding Tasks Reported by Paramedics

4.3.4. Comparing the Frequency of Exposures to High Demand Tasks of Low- and High-Population Services

4.4. Discussion

4.4.1. Physical Demands of Canadian Paramedics

4.4.2. Most Physically Demanding Tasks Reported by Paramedics

4.4.3. Comparison of Low-Population and High-Population Services

4.4.4. Participatory Ergonomics Approach to Documenting Paramedic Work

4.4.5. Practical Implications

4.4.6. Limitations

4.5. Conclusion

4.6. References

Chapter 5 - General Discussion
5.1. Summary of Key Findings ................................................................................................. 99
5.2. Strengths .......................................................................................................................... 100
5.3. Limitations ...................................................................................................................... 101
  5.3.1. Chapter 3 .................................................................................................................. 101
  5.3.2. Chapter 4 .................................................................................................................. 101
5.4. Future Research Directions ............................................................................................ 102
  5.4.1. Chapter 3 .................................................................................................................. 102
  5.4.2. Chapter 4 .................................................................................................................. 103
5.5. Conclusion ...................................................................................................................... 105
5.6. References ..................................................................................................................... 107

Appendix A – OHCOW PDD Workshop Slide Deck ................................................................. 108
Appendix B – OHCOW PDD Template .................................................................................. 159
Appendix C – Paramedic PDD Training Slide Deck ............................................................... 162
Appendix D – Paramedic PDD Data Collection Template ....................................................... 183
Appendix E – Ethics Approval and Consent Forms ................................................................. 193
List of Figures

Figure 3.1 - The three steps in the PDD process – preparation, observation & data collection, and reporting, as outlined in the revised OHCOW PDD Handbook. ............................................................. 48

Figure 3.2 - Job Simulation tasks (from left): Video 1 - road construction labourer, Video 2 - automotive quality control tester, Live - shelf stocking manual material handling task. *Video 1 retrieved from: (http://www.youtube.com/watch?v=yOqwtFmGo-M) *Video 2 retrieved from: (http://www.youtube.com/watch?v=PkV-ayhXj_s) ....................................................................... 50

Figure 3.3 - Comparison of mean physical demand element identification scores in three job simulation tasks to an 80% threshold (dashed line). Error bars indicate standard deviations. Note: Asterisk (*) represents a significant difference in means (p < .05). ................................................................. 53

Figure 3.4 - Analysis of physical demand element identification accuracy sorted by sub-category type: strength, mobility, hand-activity, and sensory ................................................. 54

Figure 3.5 – The median absolute percentage error when quantifying dimensions related to the Lift/Lower physical demand. ...................................................................................... 55

Figure 3.6 - The median absolute percentage error when quantifying dimensions related to the Push physical demand .................................................................................................................. 56

Figure 3.7 - The median absolute percentage error when quantifying dimensions related to the Grip physical demand ........................................................................................................... 57

Figure 3.8 - The median absolute percentage error when quantifying dimensions related to the Pull physical demand ........................................................................................................... 58

Figure 3.9 - The median absolute percentage error when quantifying dimensions related to the Walk physical demand ........................................................................................................... 59

Figure 4.1 - The research team and participants working through the PDD workshop.............. 76

Figure 4.2 - Outline of the over-arching research methodology .................................................. 78

Figure 4.3 - Frequency of stretcher lift & lowering tasks per shift, stratified per service. Error bars indicate standard deviations. Note: PT is an abbreviation for "patient". ................................. 82

Figure 4.4 - Frequency of patient care equipment lifting, carrying & lowering per shift, stratified per service. Error bars indicate standard deviations. ......................................................... 83

Figure 4.5 - Mean distances of stretcher (with patient) push/pulled per shift, stratified per service. Error bars indicate standard deviations. ................................................................. 84

Figure 4.6 - Breakdown of the most physically demanding perceived tasks, as reported at the end of each call. ................................................................................................................. 86
Figure 4.7 - Comparison of mean frequency of stretcher manipulation tasks per shift, between HP and LP services. Error bars indicate standard deviations. Note: Asterisk (*) represents a significant difference in means \((p \leq 0.05)\). .................................................................................................................. 87

Figure 4.8 - Comparison of mean patient care equipment lifting, carrying & lowering, per shift, between HP and LP services. Error bars indicate standard deviations. Note: Asterisk (*) represents a significant difference in means \((p \leq 0.05)\) .................................................................................................................. 88

Figure 4.9 - Comparison of mean stretcher pushing and pulling distances per shift between HP and LP services. Error bars indicate standard deviations. .................................................................................................................. 88
List of Tables

Table 4.1 – The systematic process required in order to establish a bona fide occupational requirement as outlined in the Meiorin Decision (Gledhill & Bonneau, 2000) ........................................ 72

Table 4.2 - Call frequency and component durations stratified by service. Calls observed data represents the mean frequency of calls observed per shift and accompanying standard deviation, in parentheses, based on samples obtained from each site. All other data represent the mean duration per shift of the call components in minutes and accompanying standard deviation, in parentheses, based on samples obtained from each site. ........................................................................................................... 80

Table 4.3 – A summary of patient demographic information based on the calls observed. Data represents the mean and standard deviation, in parentheses, based on the samples obtained from each service ........................................................................................................................................... 81

Table 4.4 Patient transfer equipment weight in kilograms. Note: * = East-1 and ON-North both use battery-operated hydraulic stretchers which eliminate the requirement to physically raise and lower stretcher height. Additionally, stretchers employed by ON-North reduce the requirement to load and unload the stretcher from the rear of the ambulance .................................................................................................................. 82

Table 4.5 Patient care equipment weight of three common items handled across all services: cardiac monitor, airway bag, and medication bag. Weights are described in kilograms .............................................................................................................. 83

Table 4.6 - Lifting demands per shift stratified per service. Data represents the mean and standard deviation frequency based on samples obtained from each service. Note: PT is an abbreviation for “patient”. ................................................................................................................................................. 85

Table 4.7- Mobility demands stratified per service. Data represents the mean and standard deviation frequency based on samples obtained from each service. .................................................................................................................. 85
Chapter 1 - Introduction

1.1. General Overview

Measuring and reporting the physical demands of a job is a common procedure performed by ergonomic professionals. The appropriate process for quantifying and documenting job demands information is a Physical Demands Description (PDD); a systematic procedure to identify and quantify all the physical demand elements of a job (WSPS, 2011; OHCOW, n.d.). PDDs are helpful in understanding the physical demands of a job and can be used when making legal, medical, and monetary decisions related to work. However, we know little regarding ergonomists’ proficiency when collecting PDD data and we do not know the specific training they receive to develop proficiency. Furthermore, PDDs are typically delegated to junior or novice ergonomists, and often to Joint Health and Safety Committee (JHSC) members of a workplace (Pascual & Naqvi, 2008), where novices have less experience and would likely be less proficient. While previous research has indicated that targeted training can prepare novice observers to identify workplace hazards (Silverstein et al., 1991), no research to date has evaluated the effect of training/education on PDD proficiency. This is concerning considering the important role that PDDs play in job related decisions.

A PDD can serve as a foundational resource to inform job decisions. For example, the objective information contained within a PDD can be used when developing a Bona Fide Occupational Requirement (BFOR), a non-biased essential condition of employment, screened for by employers (Canadian Charter of Human Rights, 1988). In Canada, various public safety professions (e.g., firefighters, Canadian Forces) employ a pre-hire physical abilities test recognized as a BFOR. The purpose of measuring potential hires against objective physical abilities standards is to enforce safe, efficient, and reliable job performance. The profession of
paramedicine is associated with highly physically demanding tasks pertaining to public safety however it currently lacks a standardized physical-abilities test as a BFOR.

Paramedics perform occupational tasks that are both physically and psychologically stressful. As a result of these demands, they are at a high risk of work-related stress, burnout, and physical injury (Aasa et al., 2005a; Maguire et al., 2005). On average, 35% of full-time paramedics experience work-related injuries every year, more than seven times higher than that of the average working population (Maguire et al., 2005; Maguire et al., 2014). Literature has focused on the biomechanical and physiological implications of paramedic tasks (Gamble et al., 1991; Lavender et al., 2000a; Lavender et al., 2000b; Barnekow-Bergkvist et al., 2004), however little is known regarding the overall exposure of physical demands faced by paramedics on a daily basis. Thus more research is needed to better understand the day-to-day workload of Canadian paramedics. This information can help ergonomists determine best practices to reduce injury risks, and can also help to inform the development of a robust occupational physical abilities standard for the profession.

1.2. Purpose of Thesis

The purpose of this thesis was twofold. The first purpose was to better understand the effectiveness and limitations of PDD training on novice observers by evaluating their ability to identify and quantify physical demand elements of job simulations following a training workshop (Chapter 3). The second purpose was to apply the same targeted PDD training workshop to paramedics in seven cities across Canada (Chapter 4) to describe the physical demands of their work. Following PDD training the paramedics, acting as novice ergonomists accompanying a paramedic crew, observed and characterized the physical demands of the paramedic work. This was a first step in reducing gaps in literature related to both topics and can benefit the ergonomics
community who rely on quality PDD data to inform job-related decision making when matching the demands of a job to the physical capacity of a worker.

1.3. Objectives of Thesis

In Chapter 3 it was hypothesized that following targeted PDD training, participants would be able to identify the physical demand elements that were present in three separate job simulations (two video, one live). A predefined accuracy threshold of 80% was used to indicate successful identification. Additionally, it was hypothesized that participants would be able to quantify dimensions of those physical demand elements, in the live simulation, with an absolute percentage error less than 10% different from the criterion established by a team of subject matter experts. The findings from this paper are important as they provide the first documented evidence of the effectiveness of PDD training methods on a novice’s ability to conduct aspects of a PDD.

In Chapter 4 there were three main objectives. The first was to provide an overarching description of the physical demands experienced by Canadian paramedics. Second, I aimed to identify the most important, physically demanding, and frequently occurring job tasks, a necessary step required for establishing a physical abilities test as a BFOR. Third, I aimed to determine if paramedics working in services with larger metropolitan populations were exposed to high demand tasks more frequently. As the first two objectives are descriptive in nature, there were no associated hypotheses.

1.4. Thesis Organization

This is a manuscript-style thesis which conforms to the regulations as outlined in the “Manuscript Style Thesis Requirements” of the School of Kinesiology and Health Studies. This
thesis consists of five chapters: Introduction, Literature Review, Manuscript 1, Manuscript 2, and General Discussion.
1.5. References


Chapter 2 - Literature Review

2.1. WMSDs – An Overview

Work-related musculoskeletal disorders (WMSDs) represent the majority of lost time claims reported to the Workplace Safety and Insurance Board in Ontario (WSIB) (OHSCO, 2007). These lost time injuries cost Ontario workplaces hundreds of millions of dollars yearly due to insurance claims and lost productivity from worker absenteeism. Since undergoing an overhaul in 1997, the WSIB has mandated the promotion of health and safety in workplaces to reduce the occurrence of WMSDs. The WSIB is responsible for developing occupational safety standards, educating workers and employers of these standards, and funding ongoing occupational health and safety research (Workplace Safety and Insurance Act, 1997). This review of literature is focused on issues related to physical work demands and prevention of WMSDs focusing on the paramedic profession.

2.2. WMSD Risk Factors

A WMSD is an injury to the musculoskeletal system caused by over exposure to hazardous risk factors within the workplace (Kuorinka et al., 1995). Primary hazards associated with an increased risk of injury are force, awkward postures, and repetition (OHSCO, 2007).

A muscular force refers to the force output resulting from a muscular contraction which governs movement, necessary to accomplish a task such as lifting, pushing, or pulling (Chapman, 2008). When the required force exceeds the capacity of a muscle, damage can occur to the muscle and its surrounding physical structures such as tendons, ligaments, and joints. Injury can result from a single movement requiring a very high exertion of force, or the repetition of moderate forces exerted over a long duration (OHSCO, 2007).
Body posture is another common concern regarding occupational health. Every joint in the body has a range of motion in which segments are free to move within. In neutral postures, the joint mechanics are most efficient as muscular orientation in this position is designed to support and stabilize the body segment. Movement away from the neutral posture requires a larger muscular effort to restore stability.

Repetitive movement is a common hazard associated with WMSDs. High frequency of any movement without adequate rest can lead to fatigue due to inability of the muscle to recover between exertions.

Additional hazards for workplace injury include contact stress on hard or sharp surfaces, exposure to vibration, overly long work shift durations, poorly planned work schedules, and hot or cold work climates (Keyserling & Chaffin, 1986). While exposure to any of the noted hazards increases the risk of a WMSD, the combination of two or more will even further increase that risk. Thus, workplaces should be designed and monitored to reduce the aforementioned hazards.

The Occupational Health and Safety Council of Ontario (OHSCO) suggest that developing a culture that promotes occupational safety is achievable through open communication between employers and employees. For employers, this includes developing WMSD prevention policies, employing trained health & safety and ergonomic professionals to manage and promote occupational health, and taking corrective actions when WMSD hazards are observed. Employees can also play a role in WMSD prevention by participating in workspace safety training, and reporting any WMSD hazards or experienced pain to management.
2.3. Ergonomics as a Means to Prevent WMSD

Ergonomics is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a work system, and the profession that applies theoretical principles, data, and methods to workspace design in order to optimize human well-being and overall work performance (Anon, 2000). Within occupational settings ergonomists consider physical, psychological, and organizational factors, and their relationship to the health and well-being of workers (Grandjean, 1986; Karwowski, 2001; Stanton et al., 2004). Ergonomic interventions can significantly reduce the risk of WMSDs by effectively improving working conditions (Halpern & Dawson, 1997; Haims & Carayon, 1998; Rivilis et al., 2006). Ergonomics interventions aim to eliminate the gaps between an individual’s work demands and their own physical capacity. In recent decades ergonomic research has increased and associated evidence-based processes and interventions have been incorporated into nearly every industrial sector including military, construction, transportation, manufacturing, and healthcare (Hignett et al., 2005). Assistive technologies and workplace improvements can be applied to improve productivity and reduce the risk of WMSD. In the applied setting, ergonomic researchers and practitioners are responsible for developing unique solutions to unique work-related problems to optimize workplace safety.

2.4. A Paramedic’s Job Description

Paramedics are healthcare professionals who work in conjunction with first responders and other healthcare members (police officers, firefighters, nurses, and physicians) to provide emergency medical services. With improved training and more sophisticated medical equipment, the occupation has evolved over the last several decades from providing transport, to sustaining life (Broniecki et al., 2010). Paramedics are primary responders to medical emergencies and
perform a range of tasks, including critical thinking, physical lifting and transferring of patients, performing cardiopulmonary resuscitation, administering medications, and filing administrative patient documents (Ontario Ministry of Health and Long Term Care, 2007). Paramedics experience a great deal of variability between daily job duties, likely due to the variability of the patients to whom they provide care. The occupation is best characterized by occasional bouts of high physical strain in a predominantly sedentary occupation (Gamble et al., 1991).

2.5. WMSDs and Paramedics

While it is clear that paramedics perform physically demanding work, there is limited research describing their occupational demands compared to other first responder and healthcare professions such as firefighters and nurses (Hogya & Ellis, 1990; Trinkoff et al., 2003; Paris & O’Connor, 2008; Feufel et al., 2009). Conversely there is a considerable amount of literature documenting the association between working in an ambulance and increased morbidity and mortality (Pirallo & Swor, 1994; Maguire et al., 2002; Becker et al., 2003; Khan et al., 2010). Paramedics have an estimated annual injury rate of 34.6 per 100 full time workers, well above the national average of 6.6 per 100 full time workers (Gillen et al., 2002; Maguire et al., 2005).

Paramedics are prone to a variety of injuries. The most common group of injuries is WMSDs, specifically muscular sprain and strain injuries. Sprains and strains account for 41% of all paramedic occupational injuries (Reichard & Jackson, 2010). The lower back is most affected by sprains and strains (Maguire et al., 2005). Hogya and Ellis (1990) reported a 36% prevalence of lower back pain, as measured over a multi-year evaluation in a busy urban paramedic system. Aasa and colleagues (2005) reported male paramedics were more likely to suffer from lower back pain compared to a non-paramedic population of the same demographic (Odds Ratio of 1.41, 95% Confidence Interval of 1.08-1.85). The results also indicated that female paramedics were more
likely to suffer from lower back pain (Odds Ratio of 2.17, 95% Confidence Interval of 1.37-3.44) and neck-shoulder pain (Odds Ratio of 4.13, 95% Confidence Interval of 1.42-11.9) than their male counterparts. These findings demonstrate that regardless of gender, paramedics are prone to WMSDs.

The high prevalence of reported injury is presumably linked to the physical demands of occupational tasks commonly performed by paramedics. Paramedics engage in heavy lifting and material handling activities on nearly every call they make (Lavender et al., 2000b). Epidemiological studies consistently link heavy lifting and material handling activities with the presence of lower back pain (Chaffin & Park, 1973; Garg & Moore, 1991; Andersson, 1997; Van Nieuwenhuyse et al., 2006). Literature suggests that paramedics are exposed to WMSD risk factors, and furthermore their health status is insufficiently monitored by employers (Hegg-Deloye et al., 2013) limiting the ability to detect a physical exposure limit.

The high rate of WMSDs among paramedics may also be responsible for shortening their careers. Early retirement on medical grounds (EROMG) is common among occupations which report high injury prevalence (Sarfas, 1993). Rodgers (1998) observed EROMG across different occupations over a five year period and noted that paramedics reported a much higher rate of EROMG (5.59%) compared to other occupations, including manual “blue collar” professions (2.48%), nurses (0.59%), and non-manual “white collar” professions (0.26%). This drastic difference in EROMG statistics supports the notion that the paramedic occupation is associated with increased rate of morbidity.
2.6. Physical Demands of Paramedic Lifting Tasks: Biomechanical and Physiological Stressors

Biomechanical analysis of common tasks completed by paramedics can give insight to the factors associated with high risk of back and shoulder pain experienced within the occupation. Focus group interviews with paramedic staff, coupled with ergonomic workplace analyses, have determined multiple tasks that pose potentially high biomechanical loads, such as: transferring a patient from bed to stretcher, carrying a patient and stretcher up and down stairs, and transferring a patient from stretcher to gurney into the ambulance (Conrad et al., 1997). Analysis of these tasks reveals that they do indeed require high muscular force, demand the user to assume awkward bent and kneeling postures, and are frequently repeated over the course of a call and work shift (Lavender et al., 2000a; Lavender et al., 2000b). Consequently, these are the three factors most commonly associated with increased risk of WMSDs (OHSCO, 2007).

Postural based analyses have confirmed the presence of high biomechanical loads during the performance of common paramedic tasks. Lavender and colleagues (2000a) performed a biomechanical analysis using the University of Michigan’s 3D Static Strength Prediction Program (3DSSPP) tool. They assessed 20 paramedics performing common occupational lifting tasks using a 48 kilogram dummy, representative of a small female victim. The bed to stretcher patient transport yielded average compressive spinal forces of 5476 N, well above the threshold limit value (TLV) of 3434 N, associated with high risk of lower back injury (NIOSH, 1981) in all participants. Median values indicated that only 70% of the population would have adequate back strength to perform the task and only 17% of the population would have adequate shoulder strength to perform the task.
Other commonly performed tasks may also impose considerable biomechanical loading on paramedics. As reported by Lavender and colleagues (2000a), the transfer of a patient and stretcher down a flight of stairs yielded average spinal compression values of 5100 N, again exceeding the TLV of 3434 N in all subjects. Median values indicated that only 53% of the population would have adequate back strength to perform the task and only 45% of the population would have adequate shoulder strength to perform the task. Finally, regarding the stretcher to gurney patient transfer task, spinal compression values exceeded the TLV for half of the subjects. This range differed depending on whether the subject was assuming the pushing role from the stretcher side or the pulling role from the gurney side. Median values for this task indicated that only 86% of the population would have adequate back strength to perform the task and only 35% of the population would have adequate shoulder strength to perform the task.

These results indicate that there are high biomechanical loads associated with these essential tasks. Regarding the bed to stretcher and staircase transfers, all paramedic subjects were exposed to increased risk of injury, in some cases the risk may be considered as extremely high. Even the stretcher to gurney transfer was associated with an increased risk of injury among some paramedics. However, it is not clear how often these tasks are performed over the course of a shift, limiting the ability to determine if they are primary causal factors associated with the high prevalence of WMSDs in this profession.

Certain tasks performed by paramedics can also induce increases in the stress on their cardiovascular system, on top of the high biomechanical loading demands. Paramedics are subjected to high physiological demands such that certain occupational situations can result in elevated heart rates above anaerobic threshold values for periods exceeding 11 minutes (Gamble et al., 1991). Prolonged physical exertion above the anaerobic threshold is characterised by fatigue
and exhaustion. Depending on environmental details of emergency situations, patients may sometimes need to be carried for long distances as well as up and down multiple flights of stairs. Such tasks can be quite taxing on the cardio-respiratory system of the paramedic and may require them to spend a significant amount of time working above 70% of their maximum heart rate, which is commonly associated with fatigue (Barnekow-Bergvist et al., 2004).

2.7. Non-Physical Demands of Paramedics: Stress and Fatigue

Paramedic work is associated with a number of cognitive and psychological stressors (Aasa et al., 2005; Aasa et al., 2006; Sterud et al., 2006; Isenberg & Vangelder, 2011; Donnelly, 2011). Paramedics work in an uncontrollable dynamic environment and are required to work both quickly and diligently to preserve life. In a survey of 86 full time paramedics, every individual reported exposure to traumatic events witnessed on the job (Regehr et al., 2002). Dutton and colleagues (1978) noted highly elevated values of urinary excreted catecholamines, hormones produced acutely under stress, in paramedics compared to workers of other occupations. Two types of stress are associated with the work environment of paramedics, chronic and critical (Donnelly, 2011). Chronic stress relates to work-related factors such as conflict with supervisors, lack of colleague support, and inadequate salary, whereas critical stress addresses low job satisfaction, burnout, and fatigue. These workplace stressors have been linked to a number of negative psychological health outcomes (Isenberg & Vangelder, 2011).

Accumulation of these stressful and traumatic experiences over time can lead to the development of Post-Traumatic Stress Disorder (PTSD) (Bisson & Andrew, 2007; Donnelly, 2011). PTSD is a psychiatric disorder linked to such negative mental health outcomes as diminished interest in usually significant activities, estranged feelings towards friend and family, irritability, sleep difficulty, and amnesia. A survey of the health status determined that 20% of
paramedics reported PTSD symptoms (Sterud et al., 2006), comparable to the 18% prevalence of PTSD symptoms reported by firefighters (Wagner et al., 1998). This figure is large considering the reported prevalence of PTSD in the general population is only 10% for females and 5% for males (Kessler et al., 2005).

Healthcare workers commonly participate in shift-work to accommodate 24-hour hospital and ambulance services. Shift-work typically consists of 8- to 12-hour shifts which cycle between day and night. These irregular shift hours are critical for the health care sector to accommodate traumatic events and monitor the health of patients at any time during the day. Working at different times of the day disrupts the natural circadian rhythm of the body which deteriorates the quantity and quality of sleep of the worker (Burch et al., 2009). Research has indicated that the associated decreased sleep quality of healthcare professionals exposed to shift-work results in a higher risk of fatigue, reduced alertness, impaired job performance, and a general reduced mental and physical well-being (Rajaratnam et al., 2001; Costa, 2003; Winwood et al., 2006; Archer & Spencer., 2012).

Fatigue and trouble maintaining a regular sleep pattern in paramedics has been linked to numerous negative physical and mental health outcomes. Negative health outcomes may include gastrointestinal disorders, depression, and irregularities in the function of reproductive organs (Rajan & Chandrasekaran, 2013). It is noted that paramedics tend to rely on unhealthy coping strategies such as long-term tobacco and alcohol use in order to combat the stress and decreased sleep quality brought on by shift-work (Birch et al., 2009). Cross-sectional studies report that long term exposure to shift-work in the health-care industry is associated with greater consumption of alcohol and tobacco products (Ohida et al., 2001; Kageyama et al., 2002; Ota et al., 2004).
If negative health outcomes persist via long-term exposure to shift-work it is likely that the performance of paramedics will diminish. The World Health Organization (WHO) recognized fatigue as the leading factor in medical error and injury in health care workers, contributing to $28 billion in health care costs annually (WHO, 2009). Patterson and colleagues (2011) demonstrated that more than 50% of respondents across 30 paramedic depots throughout the United States had poor sleep and reported fatigue. Furthermore, fatigue was significantly associated with increased rate of WMSDs and errors. While literature has made numerous recommendations on how to reduce the negative mental and physical health outcomes associated with shift-work, such as exercise and worker commitment to consistent work times, the recommendations lack supporting scientific evidence denoting their potential impact (Calmfors & Hoel, 1989; Harrington, 2001; Costa, 2003; Costa, 2010).

2.8. Human Factors Issues Regarding Ambulance Interior

While a great deal of literature has examined the relationships between many physical and non-physical aspects of paramedic work and their associated risks of injury, the physical work environment in which paramedics spend a majority of their shift has also been linked to WMSD risks. The rear compartment of an ambulance is designed under regulations to optimize crash worthiness (Levick, 2007; Alberta Health & Wellness, 2010); however, literature suggests that human factors are often neglected in the vehicle design as they tend to have a poor ergonomic layout (Feufel et al., 2009; Biesbroek & Teteris, 2012). The following WMSD hazards were reported regarding the ergonomic layout of the rear compartment: numerous sharp surfaces, poor accessibility to sharp disposals container, very tight and constrained workspace, and chairs which are non-adjustable in height forcing paramedics to adopt awkward postures when treating patients (Biesbroek & Teteris, 2012).
Poor postures contribute to the risk of WMSD when paramedics work in the rear compartment of the ambulance. It is estimated that paramedics spend approximately 25% of their average shift seated in the rear compartment (Ferreira & Hignett, 2005). Paramedics spend roughly 24% of their in-vehicle time assuming an extreme trunk flexion posture during non-emergency calls as a result of the poor ergonomic layout of the rear compartment (Doormal et al., 1995). This exposure to extreme trunk flexion increases to 56% of in-vehicle time during emergency calls. A postural analysis performed on paramedics whilst working inside the rear compartment of the ambulance (Gilad & Byran, 2007) reported an exposure to extreme trunk flexion for 53% of in-vehicle transfer during emergency situations. This is concerning considering findings of Punnett et al. (1991) which identified that exposure to extreme trunk flexion beyond 10% of a work-cycle is associated with increased risk of lower back injury (Punnet et al., 1991).

Furthermore, other WMSD-related ergonomic factors are associated with the rear compartment of an ambulance. Paramedics are exposed to whole body vibration (Gilad & Byran, 2007) and high noise levels not attenuated from the vehicle (Shook & Spelt, 1985), both of which linked to negative health outcomes (Seidel, 1993; Abercomby et al., 2007). Despite this knowledge, there is little information that describes the time-series of activities routinely performed by paramedics, such that the total cumulative physical exposure could be determined. Work has been done assessing the cumulative physical loads experienced by police officers who spend a considerable amount of time driving and performing other in-vehicle tasks (McKinnon et al., 2011). Cameras mounted inside of police vehicles provided data for biomechanical analysis regarding time spent in various in-vehicle postures. A similar approach would be beneficial in providing an accurate representation of the time-series of postures and physical demands required of paramedics, who face similar WMSD risks relative to other primarily sedentary emergency
response workers due to postural stress associated with the rear ambulance design (Gilad & Byran, 2007).

2.9. Previous Interventions – What Has Been Done?

A variety of ergonomic solutions have been proposed to reduce the biomechanical loads experienced by paramedics during lifting tasks. Potential solutions have been designed to reduce loading during patient transport down stairs (Lavender et al., 2007a) and during lateral patient transfers (Lavender et al., 2007b). These designs were developed and tested based on feedback from focus groups with firefighters and paramedics. For a simulated patient transport down a flight of stairs, three backboard devices were developed which were much lighter and more maneuverable compared to the standard ambulance stretcher. The backboards were designed to reduce biomechanical loads and stress on the paramedics by improving grip and handle design, reducing overall weight, and implementing wheels and treads which changed the nature of the task from a carry to a controlled lowering down the stairs. Professional paramedics performing a stair descent task using the innovative designs had significantly reduced effort of lower back and abdominal muscles, in the range of 15% – 28% of muscular activation, suggesting that they can reduce muscular stress and risk of injury associated with the task.

A bridgeboard intervention may also reduce injury risks. During simulated lateral transfers tasks of patients from a bed to stretcher, paramedics commonly grip, pull, and lift the bed sheets beneath the victim (Lavender et al., 2007b). As noted by Lavender and colleagues (2000a) these movements are associated with a high risk of back injury. Several lateral transfer design solutions were proposed and tested. The use of a bridgeboard device was associated with significantly reduced trunk flexion moment, reduced activation of lower back muscles, and reduced perceived exertion during controlled laboratory testing (Lavender et al., 2007b). These results suggest such
a design will reduce the risk of injury that is associated with the task. Focus group meetings have been held with first responders to better understand the practicality and contextual issues with these designs (Conrad et al., 2008), however there has been no research to document how effective these designs are in reducing injuries.

In order to most effectively reduce the risk of paramedic musculoskeletal injury, it is suggested that mechanical lifting devices be used to off-load weight from the human structures (Studnek et al., 2012). Use of a mechanical aide can help to control the variety of the hazards associated with lifting and transferring of patients that pose difficulty: lifting height, weight, and footing. Previous studies assessing the implementation of mechanical patient hoist devices for nursing populations in hospitals decreased the prevalence of WMSD and resulted in a significant reduction in lost work time (Yassi et al., 2001; Evanoff et al., 2003).

Mechanical lifts have a similar suggested benefit in decreasing WMSD risks when applied to the paramedic occupation. Studnek and colleagues (2012) evaluated the effectiveness of an electrically powered hydraulic stretcher in reducing injuries among paramedics in a high traffic urban paramedic depot. The powered stretcher was used during patient transfers into the rear compartment of ambulance, replacing the team lifting method used previously when handling standard stretchers. A significant reduction in the injury rate from 61.1% of full time paramedics, pre-intervention, to 28.8% of full time paramedics, post-intervention was reported. Specifically focussing on lower back injuries, use of the powered stretcher was associated with a decreased prevalence from 12.6% to 5.1%. Anecdotally, select paramedic services across Canada have implemented full-fleets of hydraulic powered stretchers and others have begun pilot studies introducing them to catchment areas of high expected call frequency. While a powered stretcher device is generally expensive, it was estimated that it would take an institution over two years to
see a return on monetary investments through the accumulated savings due to a reduction in work injury claims costs and lost time (Chhokar et al., 2005).

2.10. Future Interventions – What Else Can Be Done?

While preliminary steps have been taken to reduce risk of WMSDs in the paramedic community by reducing the required physical demands during common occupational tasks, a proactive approach to job design may prove even more effective. A large body of work within occupational health research has focussed on developing methods to match employees to work activities by considering the demands of the job and the capabilities of the worker (Keyserling & Chaffin, 1986; Smith & Sainfort, 1989; Sluchak, 1992; Larson & Ellexson, 2000). A general functional capacity evaluation (FCE) has been commonly used as a post-hire, pre-placement screen to ensure the candidate is not placed into a job for which they will be unlikely to meet its demands. The FCE test is reported as a reliable test (Matheson et al., 1995; Isernhagen et al., 1999; Reneman et al., 2002); however its suitability to matching workers to workplaces is low (Matheson et al., 2002; Gross & Battié, 2005). For this reason, more specific task based fitness tests are required, opposed to broad-based generic FCEs.

Job matching via targeted physical fitness tests is routinely applied in other emergency response services as a mechanism to reduce WMSDs. Job matching is a three-step process involving: the establishment of a thorough job function and physical demands description, developing suitable job function based physical tests to empirically measure the worker’s ability to perform routine job tasks, and job function matching which identifies specific functions of the job that can be safely performed by the worker (Isernhagen, 2006). The job matching process can also be used immediately following worker injury and it has been shown to be a reliable and effective method to help facilitate return to work (RTW). It does so by providing job-related
physical function benchmarks that can be used to guide rehabilitation with reference to the specific job demands of the worker (Vance & Brown, 1995; Grayzel et al., 1997; Loisel et al., 2002). Job matching is a collective effort which promotes confidence in those involved: the worker by gaining knowledge of their own abilities and limitations, the employer by ensuring optimized productivity, and medical professionals by providing quantitative outcome measures based on objective reliable tests (Isernhagen, 2006). While various job matching models exist, a popular example is the Activity Matching Ability System (AMAS) (Watson, 1987). The AMAS is a tool which identifies the ability of a worker to perform manual materials handling job-specific activities and has been found reliable in predicting job performance in RTW cases (Birkin et al., 2004).

2.11. Physical Capacity of Paramedics

Combined biomechanical and physiological demands data suggest that paramedics perform physically rigorous work. To effectively meet these rigorous demands safely and effectively paramedics require sufficient muscular strength and endurance. As obesity has developed into a growing international epidemic (WHO, 2000), today’s healthcare professionals face increasing demands to lift and transport this heavier population (VanHoy & Laidlow, 2009). However literature suggests that paramedics typically do not possess the expected physical capacity to meet such demands as indicated by low fitness-related health variables including VO\textsuperscript{2} max, flexibility, isometric back muscular strength, and a high body mass index (Gamble et al., 1991; Barnekow-Bergkvist et al., 2004; Crill & Hostler, 2005).

The mismatch between the occupational demands and the capacity of the average paramedic may be linked to the high reported prevalence of WMSDs in the paramedic community. It has been suggested that paramedics may be able to more efficiently meet their occupational demands
by improving their physical capacity (Aasa et al., 2008). Interventions aimed at improving worker capacity for manual materials handling (MMH) in other physically demanding sectors, including factory workers and military personnel, have demonstrated improved muscular strength and MMH capacity (Sharp et al., 1993; Knapik et al., 1997; Williams et al., 2002). Aasa and colleagues (2008) measured the effectiveness of a 12 month exercise intervention on paramedic task performance. A population of paramedics were prescribed to either a training or control group, between which no significant difference existed regarding age, employment time, weight, or physical activity level prior to intervention. The training group was prescribed a regime of exercises aimed at increasing muscular strength and cardiovascular outcome measures while the control group was told to maintain their normal exercise habits. The testing protocol consisted of simulating a team lift of a weighted stretcher (total 95kg) up and down a large flight of stairs twice (Barnekow-Bergkvist et al., 2004). The trained group performed the testing protocol in less time and had significantly reduced blood lactate accumulation during the post-test, a value related to one’s increased ability to work for a longer duration before fatiguing.

2.12. Physical Demands, Functional Capacity and Bona Fide Occupational Requirements

Job matching has been a successful practice in ergonomics by seeking a middle ground between the employer’s needs, job demands, and the employee’s capability. However, if a company choose to deny employment based on a lack of physical ability, there is a legal requirement that the minimum standard for physical ability is a Bona Fide Occupational Requirements (BFOR). This process requires contributions and agreement from scientific and legal professionals in order to determine what physical demands are essential to the job, and what standard of capability is necessary in order to meet that demand. This process represents the legal application of the job matching model.
Many physically demanding occupations have established pre-hire physical abilities tests as BFORs that must be met by potential employees. The Canadian Government states that a BFOR is a condition of employment that is imposed in the belief that it is necessary for the safe, efficient, and reliable performance of the job and which is objectively, reasonably necessary for such performance (Canadian Charter of Human Rights, 1988). It has become a common practice in public safety occupations to include a Job Specific Physical Fitness Protocol, or physical abilities test, as a BFOR (Gumieniak et al., 2011). A physical abilities test can only be implemented for occupations in which ineffective job performance can result in a loss of life or property (Jamnik et al., 2010). As successful job performance is necessary for the safety of the worker, co-workers, and general public in a public safety occupation, it is mandatory for workers to demonstrate the minimum physical capabilities required to match their job demands (Gumieniak et al., 2011).

Any exclusion or refusal of employment based on failure to meet a physical abilities test is not deemed discriminatory, provided that the employer has established a BFOR under guidelines imposed by the Development and Validation of Task-specific Fitness Tests and Standards (Gledhill & Bonneau, 2000). To meet the criteria as a BFOR, a physical abilities test must undergo three phases: identifying the most common, essential and physically demanding tasks, measuring and validating the physical demand of tasks, and developing tests which set the minimal standards required for successful job performance. Following this prescription, fitness tests have been established as BFOR in several high risk Canadian public safety occupations such as police (Physical Abilities Requirement Evaluation), firefighters (Candidate Physical Ability Test), and the Canadian Armed Forces (Primary Reserve Applicant Fitness Test).

Two types of tests are commonly used during a physical abilities test; a basics ability test, and a job simulation (Scott & Reynolds, 2010). Basics ability tests are designed to assess a broad
range of physical fitness parameters including muscular strength, muscular endurance, aerobic capacity, and flexibility. These types of tests often measure the capacities of individual aspects of function highlighting underlying strengths and weaknesses. Additionally, job simulations are tests which duplicate essential workplace tasks (American Educational Research Association, 1999). Job simulation tests have been used in public safety occupations such as law enforcement to evaluate an applicant’s ability to perform physically demanding tasks which are critical in the field, including quickly entering and exiting a vehicle, climbing a fence, and restraining a subject (Scott & Reynolds, 2010). This method is also applied to some MMH jobs to identify the maximal work speed or load an applicant can tolerate efficiently. These job simulation tests are inexpensive and have been found to be strong predictors of job performance and injury occurrence (Mayer et al., 1988; Gebhardt & Crump, 1990).

The introduction of a regulated physical testing procedure could prove effective in job screening to maximize employee performance and minimize risk of WMSD within the paramedic profession. Previous research has indicated that both aspects of the physical abilities test, the basics ability and job simulation portions, produce reliable tests results when properly developed and administered (Myers et al., 1984; Jackson et al., 1993; Myers et al., 1993). Literature also demonstrates strong validity of physical abilities test scores and work performance when an effective scoring criterion is developed between supervisors and peer workers (Hogan, 1991; Blakley et al., 1994; Lechner et al., 1994).

2.13. Characterising the Physical Demands of a Workplace: The First Step towards Developing a Pre-Hire Physical Abilities Test

Documenting the physical demands of paramedics is a critical next step in developing a pre-hire physical abilities test. The Physical Demands Description (PDD) is the appropriate tool
to document these demands. The Occupational Health Clinics for Ontario Workers (OHCOW) defines a PDD as a systemic procedure to quantify, and evaluate all of the physical and environmental demands of all essential and non-essential tasks of a job (OHCOW, n.d.). Essential tasks are necessary for the purpose of the job while non-essential tasks are considered supplementary or auxiliary in nature (Gagne, 2010). PDDs are important for an occupation in that they objectively describe job demands in a standardized way, identifying such physical requirements as lifting, walking, carrying, bending, writing, and typing (Fraser, 2003). The described physical demands can also be used to identify potential issues regarding health, safety, or performance concerns. Finally, PDDs are beneficial in the process of returning injured workers to the occupation by identifying specific job tasks that are within the worker’s cognitive, behavioural, physical, and psycho-emotional capacities (Lysaght et al., 2008). Each workplace is unique, thus a PDD should be tailored to the occupation. The most important factor to consider when completing a PDD is that it adequately addresses five components of the PDD process. These components are: 1) Determining the job function, 2) Verifying the job function, 3) Identifying physical demands associated with the job function, 4) Quantifying the physical demands of each job function, and 5) Recording and reporting all processes (Sinden & MacDermid, 2013).

2.14. The Need to Develop a Paramedic-Specific Physical Demands Description

To best document the physical demands of paramedics, a PDD template should be developed to specifically capture intricacies of paramedic work. While the biomechanical demands of particular paramedic tasks have been studied (Gamble et al., 1991; Lavender et al., 2000a; Lavender et al., 2000b; Barnekow-Bergvkist et al., 2004), little is known regarding the frequency, repetition, and environment associated with the performance of these demands over the course of a
shift. Conducting a PDD of paramedic work is one way to gather that information. However, conducting a PDD within the paramedic profession may not be straightforward. First responding emergency professional are generally subject to variable and unpredictable workloads (Bos et al., 2004) posing a challenge when one aims to characterize the average or typical physical demands. As such, a single-day analysis (as is the standard practice in ergonomics) would be unlikely to fully capture the variability in the workload and demands of paramedics. Therefore, PDD data obtained from a larger volume of observations is necessary to account for the variability associated with factors such as: the types of emergencies, time of day, season, and day of the week. To adequately obtain a high-volume of PDD data it is useful to engage paramedics into the data gathering process and to ensure that they are able to capture quality data.

2.15. Knowledge Gaps Regarding the Physical Demands Description

There is no industry standard for performing and reporting PDD information. Despite widespread use, the processes for gathering and reporting PDD information remain inconsistent. In Ontario, four major public sector health and safety agencies each provide unique PDD reporting templates (WSIB, n.d.; WSPS, 2011; OHCOW, n.d.; IAPA, 2009). In addition, most private sector companies often customize their PDD reporting methods further, creating more ambiguity in how PDD data are reported. While it is likely that each template describes essential demands of a job; this variability may impede a user’s ability to find specific physical demands information in a timely and effective manner. However, this inconsistency in reporting may not be the most pressing limitation to the PDD process; a more important concern may be the lack of understanding about how practitioners learn to gather PDD information, or their ability to accurately identify and quantify physical demands as a precursor to the reporting. Considering the
widespread use of PDD information for decision making, it is important to consider how traditional PDD training prepares observers in gathering high quality PDD data.

2.16. Introducing Workplace Ergonomics - “Novice Observers”

In-plant ergonomics programs are organized and conducted by ergonomists with expertise and training in ergonomics. In an effort to reduce workplace injuries, ergonomics professionals will teach employees safe work habits and proper workstation setups as to reduce the risk of WMSDs (Haines & Wilson, 1998). Ergonomists are responsible for monitoring both the large scale operations of plant productivity and evaluations as well as specific WMSD concerns of individual workers. Pascual and Naqvi (2008) identified, through a survey completed by ergonomic practitioners, that PDDs have an intermediate ease-of-use indicating that “some ergonomics knowledge is required”. Additionally responses to the same survey indicated that the PDD is among the most frequently used tools by JHSC members, typically comprised of workers with limited ergonomics knowledge and training.

Research has shown that participatory ergonomic interventions, which engage workers in improving their own workplace and being involved in the solution, is an effective method to reduce WMSDs (Haines et al., 2002; Straker et al., 2004; Lee, 2005). Such an approach can be beneficial both for in-plant ergonomists to spend more time focusing on large scale plant operations while also facilitating safe work habits for employees. This style of ergonomic intervention is useful in training workers in ergonomics knowledge. With these workshop-style approaches, workers learn observatory skills which they can use to identify WMSD hazards.

Silverstein and colleagues (1991) evaluated the effectiveness of training novice observers to identify WMSD workplace hazards, an important requirement in the participatory ergonomics
The program was designed to incorporate similar methodology used by Robins and Klitzman (1988) who trained members of a Joint Health and Safety Committee (JHSC) to perform workplace evaluations of colleagues in order to identify WMSD hazards, a procedure typically performed by an ergonomics expert. The program consisted of a 2-week workshop in which university educators provided ergonomics training to a group of 20 trainees: skilled trade workers, process engineers, and union representatives. The workshop objectives were to enable trainees to gain basic knowledge of ergonomics, learn to identify potential WMSD hazards, and become familiar with ergonomic tools such as the Basic Job Checklist (BJC), Postural Discomfort Survey, Symptoms Questionnaire, and Documentation of Ergonomic Changes. The workshop was structured such that trainees spent the first three days learning the necessary information in a formal classroom setting followed by two days working with instructors on the plant floor analyzing jobs in their area in a practical manner.

To measure the effectiveness of the program trainees completed BJC s, which evaluate a worker’s risk of upper extremity cumulative trauma disorders, postures, environmental hazards, metabolic output, and materials handling, on two videos of jobs that would likely be completed in their workforce. Test scores were compared to those of the university instructors, which were considered the gold standard. The comparison determined high similarity of answers between the trainees and instructors on BJC answers, ranging from 78% to 98% agreement. These results suggest that training novice observers could be an effective method of documenting and analyzing the physical demand exposures of their co-workers.

Such structured participatory programs can be advantageous and have become common for driving ergonomic intervention in workplaces; however, questions remain regarding the validity and reliability of training. For such a widely practiced approach, there has been limited research
since Silverstein and colleagues (1991) demonstrating the effectiveness of training novice observers in ergonomics. Further, research cautions the use of this approach due to a lack of supporting validity data (Stanton & Young, 2003). Furthermore, the existing literature has been aimed at instructing workers to identify WMSD hazards by way of controlled checklists. Assessing physical demands is a more sophisticated process which may require a higher degree of training to identify and quantify physical demands measurements.

2.17. Implementing a Trained Novice Observer Approach with Paramedics

Guided training may be an effective approach to engage, and educate paramedics about how to observe and analyze the physical demands of their profession. By supplying adequate knowledge and supporting tools they may be able to accurately observe and report physical demands, providing the ability to gather a larger sample of data, while overcoming privacy and safety concerns associated with an ergonomist riding along in the back of the ambulance. While a paramedic novice ergonomic observer does not possess the same expertise as an ergonomics professional, their subject matter experience could prove highly advantageous in observing demands within such a dynamic occupation. In addition, an ergonomist riding along in the ambulance may cause numerous issues. Paramedics are required to perform duties at a pace necessary to sustain life and may be unable to communicate with an ergonomist to describe the components and function of certain tasks, a procedure common while performing PDDs in occupations where time is not as critical. In such a situation a professional paramedic would be beneficial as they will be familiar with the high-alert situation and will know to refrain from distracting and or impeding the work to facilitate data collection. Furthermore paramedics will be able to perform a PDD with greater focus and less chance of distraction as they are more accustomed to graphic sights which can accompany emergency situations.
Quality and sincerity of PDD data collected may also be optimized by peer observation as opposed to traditional PDD observation of ergonomics professionals. It has been suggested that when a person is aware that they are being observed as part of an experimental research, there may be alteration effect in the way they act or perform, known as the “Hawthorne effect” (Reiss, 1979; Carlopio, 1982). Altered performance of duties and decisions may implicate the performance of life sustaining duties as well as skew the physical demands being documented. Previous literature observed the Hawthorne effect in third-party paramedic observation (Campbell et al., 1995). It is plausible that peer-observation, from that of other paramedics, may reduce this effect to ensure that physical demand activities are performed without alteration.
2.18. References


Chapter 3 - Evaluating the ability of recently trained novices to identify and quantify physical demands elements in multiple job simulations: A pilot study

Brendan Coffey¹, Curtis VanderGriendt², Steven L. Fischer¹

¹ School of Kinesiology and Health Studies, Queen’s University, Kingston, Ontario, Canada
² Occupational Health Clinics for Ontario Workers Inc., Ontario, Canada
Abstract

A Physical Demands Description (PDD) is a systematic process for documenting work requirements. PDD data are commonly used to make legal, medical, and monetary decisions related to work. Despite its importance, PDD data are often gathered by novice or early career ergonomists, where we have limited knowledge about their proficiency to complete a PDD. The purpose of this pilot study was to evaluate how well a group of novice observers could identify and quantify physical demands elements embedded within three job simulations following a formal PDD training workshop. The workshop was based on the revised Occupational Health Clinics for Ontario Workers (OHCOW) PDD Handbook. Following training, participants were able to identify physical demands elements with a success rate of at least 80%, but were not able to quantify those elements within 10% of the subject matter expert determined criterion. These data suggest that practitioners should exercise caution when sending novice ergonomists out on their own to complete PDDs.
3.1. Introduction

Quantifying the physical demands of a job is critical to understanding work requirements. The appropriate process for quantifying and documenting job demands information is the Physical Demands Description (PDD); a systematic procedure to identify and quantify all the physical demand elements of a job (WSPS, 2011; OHCOW, n.d.). While many terms such as Physical Demands Analysis, or Job Demands Analysis, are also often used when referring to this process, the goal of each is the same: to objectively define and describe the demands of the job. At a high-level, a PDD is completed in three steps: preparation, observation and data collection, and reporting. During preparation, necessary stakeholders are recruited (e.g., worker, employer, management, union representative, human resources, etc.) and work together to schedule a job observation, ensuring that the expected variability in job demands between shifts or work days is captured. During observation, a worker is observed performing their typical job duties throughout one or multiple shifts while the observer records and measures physically demanding elements (e.g., frequency, duration, weights, forces, height, distance, etc.). This information is then compiled to produce a detailed report documenting the physical demands of that job.

The PDD serves many purposes and can be used by a variety of professionals. PDDs can be used by insurance providers when trying to understand a job to make a decision about monetary compensation for an injured worker (Jones et al., 2005). PDDs can also be used to provide employers with objective indicators of job requirements and can be used when developing job descriptions or during the job screening process (Hogan & Bernacki, 1981). Health care practitioners (e.g., physiotherapists, physicians, etc.) can refer to PDD data to gain a better understanding of the tasks and processes that their patients are required to perform at work. With
this information, health care providers can tailor effective treatment plans to assist injured workers in recovering and in returning to work quickly and safely.

Despite widespread use, the processes for gathering and reporting PDD information remain inconsistent. In Ontario, four major public sector health and safety agencies each provide unique PDD reporting templates (WSIB, n.d.; WSPS, 2011; OHCOW, n.d.; IAPA, 2009). In addition, most private sector companies often customize their PDD reporting methods further, creating more ambiguity in how PDD data are reported. While it is likely that each template describes essential demands of a job, this variability may impede a user’s ability to find specific physical demands information in a timely and effective manner. However, this inconsistency in reporting may not be the most pressing limitation of the PDD process; a more important concern may be the lack of understanding about how practitioners initially learn to gather PDD information, or how accurately practitioners can identify and quantify physical demands as a precursor to reporting. Considering the widespread use of PDD information for decision making, it is important to determine how traditional PDD training prepares observers in gathering high quality PDD data.

Accurately gathering PDD data requires some level of expertise and training. Observers must be able to correctly and accurately identify and quantify physical demands. Indeed, professional ergonomists, often tasked with completing PDDs are well educated; where most commonly hold a Master’s or Doctoral degree, and have experience; where the majority report more than ten years of ergonomic work experience (Dempsey et al., 2005). However, anecdotally, professionals note that the established ergonomist is not completing the PDD, but rather it has been delegated to a novice ergonomist. Further, as a technique or skill, PDDs may not necessarily be a common element taught to students that may choose to embark on a career in ergonomics. Taking these
two issues into account, presently, little is known about how effective PDD training is, or how well novice ergonomists might be able to complete a PDD.

A 2008 survey sent exclusively to practitioners who held the designation of Canadian Certified Professional Ergonomist (CCPE) reported that the PDD has an intermediate ease-of-use and indicating that “some ergonomics knowledge is required” (Pascual & Naqvi, 2008). Responses from the same survey indicate that the PDD is among the most frequently used tools by Joint Health and Safety Committee (JHSC) members, typically comprised of workers with limited ergonomics knowledge and training. However, Stanton and Young (2003) suggested caution when inviting novices to use observational tools. They found that novice observers report acceptable values of intra-observer reliability but measurements are not reliable between observers. As the PDD is commonly performed by relative novices in ergonomics, such as JHSC personnel, it is important to ensure that training methods yield qualified PDD evaluators.

The purposes of this study were to conduct a preliminary evaluation of the ability of novice observers to identify and measure physical demand elements following a PDD training workshop. It was hypothesized that participants would correctly identify physical demand elements with a success rate of at least 80%. It was also hypothesized that participants would be able to accurately quantify demands with an absolute percentage error (APE) less than 10% different from measurements obtained by an ergonomic professional. The intent of this research was to explore if a simple, traditional PDD training model is sufficient, or if a deeper more comprehensive investigation of PDD training and proficiency is warranted.
3.2. Methods

3.2.1. Participants

Ten university aged students (3 males, 7 females) enrolled in an undergraduate occupational biomechanics and physical ergonomics class during the middle of the semester, with no prior PDD knowledge or experience, volunteered for participation. Participants were enrolled in undergraduate degree programs related to Kinesiology, Physical Education, or Health Sciences. This project was approved by the Queen’s University’s Research Ethics Board (Appendix E); all participants provided their informed consent.

3.2.2. Developing a Physical Demands Data Training Resource

In collaboration with the Occupational Health Clinics for Ontario Workers (OHCOW) we revised and updated their existing PDD Handbook. OHCOW was interested in updating their existing resource to meet the changing needs of its industry stakeholder. In concert, we were interested in seeking a publically available, reputable resource to form the backbone of the training workshop. Aligned around a mutual interest to generate an up-to-date practical resource, we worked together to revise the handbook and develop a training workshop that could be administered over the course of two lectures (three hours total) within an undergraduate ergonomics course.

3.2.3. Revising the PDD Handbook

The PDD Handbook was revised through a systematic process by the research team which consisted of the following subject matter experts: a CCPE, University Professor (PhD), and a Graduate Student studying in the area of ergonomics. First, the team reviewed the existing PDD Handbook to identify potential physical demands elements that needed to be added or removed.
By surveying other freely available PDD resources, a list of physical demand elements and their respective requisite measurements were documented. This list was compared with the original OHCOW version, and new elements were added where identified. Although many of the surveyed resources also described postural demands, (i.e., those pertaining to specific joint angles, such as the degree of trunk flexion, or postures, such as “hands at/above shoulder height”), they were not included in the revised handbook. After deliberation, we agreed that while postural information is important, it often varies due to personal technique, or the anthropometrics of the worker. As such we did not consider it to be a physical demand element, but rather a method by which a worker might leverage their capability in order to meet a demand (i.e. a worker could choose to stoop or squat to lift a box).

In addition to identifying physical demand elements, emphasis was also placed on the need to measure dimensions of those elements objectively and precisely (i.e., “the 20 kilogram box was lifted 5 times per hour from origin – 25cm to destination – 90cm”, as opposed to “the heavy box was lifted occasionally from shank to waist height”) to ensure that the final report was clear. Lastly, to facilitate effective knowledge transfer, the research team also developed a series of flow-charts and diagrams to aid in visually describing the process. As an example, pictograms were used to communicate physical demand elements and PDD processes where these types of images have been previously shown to be an effective way to comminute this type of information (IWH, 2012).

3.2.4. Developing the PDD Workshop

A three-hour interactive PDD education workshop, based on the framework outlined in the revised handbook, was developed (workshop slide deck in Appendix A). The workshop guided learners through the three-step process (Figure 3.1). The workshop consisted of brief periods of
lecture, interspersed with break-out sessions where participants were given the opportunity to practice and apply their learning. For example, participants were shown sample activities and were asked to work in small groups to describe the job purposes, job tasks, and identify physical demand elements. In addition participants were also provided an opportunity to work with a force gauge to practice measuring weights and push/pull forces.
The three steps in the PDD process – preparation, observation & data collection, and reporting, as outlined in the revised OHCOW PDD Handbook.
3.2.5. Physical Demand Element Identification Task

To evaluate participants’ learning, one-week following the lecture, they were invited to the laboratory where they were asked to independently observe three job simulations: two video-based examples, and one live example. Video 1 portrayed a road construction labourer, where the worker used a shovel and rake to spread and level asphalt (Figure 3.2 – left pane). The video was approximately one minute in length where two subject matter experts agreed that the worker was exposed to the following physical demand elements: Push, Pull, Reach, Grip, Stand, Walk, Balance, and Vision. Video 2 portrayed an automotive quality control tester, where the worker manually inspected the worthiness of a car door by exerting forces using a series of different techniques (Figure 3.2 – center pane). The video was approximately one minute in length where two subject matter experts agreed that the worker was exposed to physical demand elements including: Push, Pull, Crouch, Grip, Stand, Walk, Feel, and Vision. The live job simulation was performed by an actor mimicking a manual materials handling task of stocking shelves (Figure 3.2 – right pane). The task was approximately 3 minutes in length, during which time the following physical demand elements were performed: Lift/Lower, Push, Pull, Grip, Crouch, Stand, Walk, and Vision. Participants were instructed to identify and list all of the physical demand elements observed across the three job simulations.

3.2.6. Physical Demand Element Quantification

During the live job simulation, participants were also asked to quantify requisite dimensions of each physical demand element that they identified. Participants were provided with tools commonly used by ergonomists including a: measuring tape, force gauge, stopwatch, pencil, and paper. Using the OHCOW PDD template, provided in Appendix B, participants were instructed to measure and record relevant dimension of each physical demand element identified.
(e.g., a Reach requires the evaluator to quantify the dimensions of: Frequency, Height, Distance, and Hand(s) Used). Participants were not given a time limit to complete the quantification task.

Figure 3.2 - Job Simulation tasks (from left): Video 1 - road construction labourer, Video 2 - automotive quality control tester, Live - shelf stocking manual material handling task.
*Video 1 retrieved from: (http://www.youtube.com/watch?v=yOqwtFmGo-M)
*Video 2 retrieved from: (http://www.youtube.com/watch?v=PkV-ayhXj_s)

3.2.7. Data Analysis

A criterion method was used to evaluate participant performance (both physical demand element identification and quantification). Using this approach, the subject matter expert team reviewed each activity and came to consensus on the physical demands that were apparent in each simulation. This list was used as the criteria for evaluating participants’ identification accuracy. During the identification tasks, participant’s list of physical demand elements, from all three job simulations, were compared against the criterion list, where one point was awarded for each element correctly identified. A threshold of 80% accuracy was used to classify the participant as successful or un-successful regarding their ability to identify physical demand elements. The 80% criterion was chosen as a commonly used benchmark for to demonstrate proficiency when seeking workshop-based certification within various health and safety associations, such as the Heavy Construction Safety Association of Saskatchewan (Safety Program Certificate of Recognition), the Back School of Atlanta (Practice & Management of
Occupational Ergonomics), or the National Association of Safety Professionals (Certified Ergonomics Technician).

During the quantification task participants were challenged to quantify requisite measurements of each physical demand element identified during the live job simulation, such as the force applied to push an object or the horizontal reach during a lift/lower. The criteria evaluating the accuracy of a measurement was based on pre-determined measurements obtained by a member of the subject matter expert team. To measure accuracy of physical demand elements identified in the live job simulation task, participant’s APE was calculated by comparing participant’s measurements (Reported Value) with the criterion measurements established by the subject matter expert (Actual Value), as illustrated below:

\[
APE = \left| \left( \frac{\text{Reported Value} - \text{Actual Value}}{\text{Actual Value}} \right) \right| \times 100\%
\]

Presently, there is no research or metric to indicate how accurate PDD data should be. As such we considered the arbitrary threshold of 10% APE to be a fair metric. The threshold was intentionally selected to be more conservative than that used for physical demand identification, as the quantification of physical demands elements requires a higher degree of skill and expertise due to the complexity of hands-on measurements. APE was calculated for all measured data. When physical demand elements were further described with nominal variables (i.e., grip type, hand(s) used) rather than specific measurements, no APE was calculated.

Data were transcribed to reflect the frequency of correct physical demand element
identifications and quantified values of APE in measurement of physical demand elements using Microsoft Excel (Redmond, WA).

3.2.8. Statistical Analysis:

Data were compared using IBM SPSS Statistical Software (Armonk, NY, USA). An independent samples t-test was used to determine if participants, on average, adequately identify at least 80% of the physical demand elements present in each of the job simulations. To determine the effect size for identification task findings, Cohen’s $d$ was calculated (Cohen, 1988) where a $d$ value of .20 represents a small effect, .50 a medium effect, and .80 a large effect (Cohen, 1992). When considering the ability to accurately quantify dimensions associated with identified demands, a Wilcoxon rank-sum test, a non-parametric alternative to the independent samples t-test, was used. Group means were compared to the 10% RE threshold value to assess the groups’ measurement accuracy. A non-parametric test was chosen as the measurement data was not normally distributed. For both identification and quantification tasks, a p-value < 0.05 was chosen to detect significant differences. To determine the effect size of quantification task findings, Pearson’s $r$ was calculated (Rosenthal, 1991) where an $r$ value of .10 represents a small effect, .30 a medium effect, and .50 a large effect (Cohen, 1992).

3.3. Results

3.3.1. Physical Demand Element Identification

Participants were able to accurately identify physical demand elements with a success rate of 80% or more in all three job simulations. In fact, participants’ identification accuracy when viewing Video 2 ($M = 90.0$, $SD = 9.8$) was significantly higher than threshold, $t(9) = 3.21$, $p = 0.011$, $d = 2.13$ (Figure 3.3). No differences were found between physical demand element
identification and the threshold for Video 1 \((M = 80.0, SD = 17.8)\) and Live \((M = 82.5, SD = 12.0)\) job simulation tasks.

Figure 3.3- Comparison of mean physical demand element identification scores in three job simulation tasks to an 80% threshold (dashed line). Error bars indicate standard deviations. Note: Asterisk (*) represents a significant difference in means \((p < .05)\).

Group means at or above the threshold indicate that participants demonstrated the required 80% proficiency in identifying physical demand elements. As a group, the 80% threshold was met for all three job simulations when averaged, however individual participants varied in their identification accuracy. Three participants failed to identify at least 80% of physical demand elements that occurred within each video, where scores ranged from 50% to 75%.

Drilling deeper, an analysis was performed with respect to participants’ ability to identify the specific sub-categories of demand elements, as determined by the research team through adaptation of the WSPS PDA Resource (WSPS, 2011), comprised of: strength, mobility, hand-activity, and sensory demands. Participants were more successful at identifying strength and hand activity related demands, relative to types of physical demand elements (Figure 3.4). Conversely, sensory demands and mobility demands were missed most often. As there was an uneven distribution of physical demand elements within each sub-category, descriptive statistics
were used to analyze these data. This data suggest that novice observers are not able to identify all types of physical demand elements with the same accuracy.

![Graph](image)

Figure 3.4 - Analysis of physical demand element identification accuracy sorted by sub-category type: strength, mobility, hand-activity, and sensory.

### 3.3.2. Physical Demand Element Quantification

Dimension of each physical demand element were quantified during the live job simulation of a shelf stocking task. The job exposed the worker/actor to eight physical demand elements: Lift/Lower, Push, Grip, Crouch, Pull, Walk, Stand, and Vision, where each contained several dimensions for quantification (Appendix B). The following graphs (Figures 3.5, 3.6, 3.7, 3.8, and 3.9) reflect data compared using a non-parametric test that compares median values, thus a box-and-whisker plot was used to represent APE. Negative error bar indicates 1st quartile values, lower half of the box plot indicates 2nd quartile values, upper half of the box plot indicates 3rd quartile values, and the positive error bar indicates 4th quartile values. An asterisk (*) represents a significant difference (p ≤ 0.05) between the median APE error and pre-determined criterion threshold (dashed line).
3.3.2.1. Lift/Lower

For most measurements, the group median APE was equivalent to the 10% threshold. Participants measured the following dimensions of the Lift/Lower physical demand element: the weight of the object, the height it was lifted/lowered, the horizontal reach associated with the lift/lower, and the frequency of occurrence. Based on the median APE, participants’ could not accurately measure the reach distance, within the pre-defined 10% error threshold, \( Z = -2.19, p = 0.028, r = -0.58 \) (Figure 3.5). While not statistically significant the median APE for the weight and height measures both had large interquartile range (IQR). The IQR for both measurements (weight – 49%, height – 56.5%) indicates that the APE was variable between participants, suggesting that while some participants were able to measure within the pre-defined error limits, many were not able to do so.

![Figure 3.5](image)

Figure 3.5– The median absolute percentage error when quantifying dimensions related to the Lift/Lower physical demand.
3.3.2.2. Push

Participants measured the push force required to initiate the trolley’s movement, the height at which the trolley was pushed, the total distance pushed, and the frequency for which the pushing task occurred. Based on the median values, at the group level APE was significantly greater than the threshold, $Z = -2.70$, $p = .007$, $r = -.64$ when considering the push distance measurement (Figure 3.6). A large IQR was noted for the force measurement (93.5%) indicating that several participants had APE values above the threshold, up to 308% for one participant. Push height APE was significantly lower than threshold, $Z = -2.59$, $p = 0.008$, $r = -.61$, indicating that participants measured this demand element well within the pre-defined threshold.

Figure 3.6 - The median absolute percentage error when quantifying dimensions related to the Push physical demand.
3.3.2.3. Grip

Participants measured the height at which the grip occurred, and the frequency of grip occurrence. The median APE for the height measure was significantly higher than the threshold, \( Z = -1.96, p = 0.05, r = -.52 \) (Figure 3.7). Regarding frequency, all participants but one quantified the frequency value correctly (zero APE).

![Figure 3.7](image_url)

Figure 3.7- The median absolute percentage error when quantifying dimensions related to the Grip physical demand.

3.3.2.4. Pull

Participants measured the pull force required to initiate the trolley’s movement, the height at which the trolley was pulled, the total distance the trolley was pulled, and the frequency of pulling task occurrence. While participants’ height measurements were more than acceptable, \( Z = -2.70, p = .005, r = -.64 \), the APE in measured pull forces was significantly higher than the
threshold, $Z = -2.49$, $p = 0.012$, $r = -0.58$ (Figure 3.8). Additionally, a large IQR was noted for the force measure (338.75%), where nearly all participants were at or above threshold, up to a maximum of 950% APE.

Figure 3.8 - The median absolute percentage error when quantifying dimensions related to the Pull physical demand.

### 3.3.2.5. Walk

When the walk element was identified, only the total distance walked required quantification as it was the only ratio variable used to describe the walk physical demand element. The APE in the distance measure was significantly higher than threshold, $Z = -2.36$, $p = .017$, $r = -0.68$ (Figure 3.9). All participants measured values, where the APE was 19% – 67%, well above the 10% threshold.
3.4. Discussion

3.4.1. Physical Demand Element Identification

Physical demand element identification is an important step when gathering data in the PDD process. We hypothesized that participants would be able to identify physical demand elements in multiple job simulations at or above our pre-defined criterion of 80% following completion of the PDD workshop. The data support our hypothesis where, on average, participants correctly identified 80% of the physical demand elements. Further, these findings are consistent with previous research investigating the effectiveness of lecture-based ergonomics trainings. For example, King et al. (1997) reported a group mean proficiency score of 79% after receiving training on ergonomics and job redesign, while Robertson and colleagues (2009) reported scores between ~80% - 90% following office ergonomics training. Introductory ergonomics training seems to produce proficiency at or above 80%.

Figure 3.9 - The median absolute percentage error when quantifying dimensions related to the Walk physical demand.
Participants were often able to correctly identify strength and hand activity-based elements but were less accurate in correctly identifying mobility and sensory based elements. While this trend could be a result of limited sample size, the result is similar to previous research. A study by Silverstein and colleagues (1991) indicated that trainee’s accuracy in identifying and classifying specific postures, when using pencil and paper-based postural observation tools, varied between ~40-90% following ergonomic training. This is similar to our results, albeit we asked participants to identify mobility elements, which encompass a broader set of movement-based actions, without any prompts. The vantage point of observers could affect which elements were observed and reported based on where they were standing relative to the live worker or the angle from which the video was captured from the two recordings. While our preliminary explanation requires further research, the results of this study suggest that trainees may be limited in the ability to correctly identify non-strength or hand-activity based demands. Senior consultants should exercise caution when delegating PDD to trainees, particularly where those jobs may require a lot of mobility or sensory based demands. Additionally, as these types of demand elements were found to be more difficult to identify, more specific training could be directed towards observing their subtleties.

3.4.2. Physical Demand Element Quantification

Physical demand element quantification is also a critical aspect of developing an accurate PDD. The second hypothesis stated that participants would be able to measure physical demand elements within an absolute percentage error threshold of 10%. While select measures were quantified within the APE threshold, others were not. Therefore, the data do not fully support the second hypothesis. One major implication of inaccurate PDD data relates to its use in the return to work process for an injured worker. Health care practitioners often perform job function matching, comparing the demands of the job to the abilities of the worker. This process allows
them to determine which tasks can be performed safely and which require modification by ergonomic tools, job design, or rotational work schedule (Isernhagen, 2006). For safe and effective job matching, job demand quantities must be accurate. Inaccurate data could impair the process of job matching by matching a vulnerable worker with job demands that may actually exceed their physical capacity if the demands are under-estimated, or, by excluding a viable worker from a role if the demands are over-estimated. Our findings of large APE in many measures, coupled with the industry need for accurate demands data, emphasize the importance of increasing educational efforts towards developing measurement skill. Where our workshop training seemed to inadequately prepare novice observers to accurately measures aspects of physical demand elements, other educators may look to focus more time and effort towards this aspect of PDD collection.

While median values were often near 10%, the range of APE between participants was large. It is possible that these errors may pertain to the participant’s familiarization with the use of a force gauge, resulting in inaccurate measurements. In all physical demand elements requiring force or weight quantification (e.g., Lift/Lower, Push, Pull) large variability in APE was present between participants, although the median error was only significantly greater than the 10% criterion when considering pull force. Forces measured by participants regarding with the Lift/Lower and Push elements tended to be over-estimated compared to the actual value, while measured forces for the Pull element were distributed above and below the actual value. Bao et al. (2009) suggest that variations in force production using a force gauge can be attributed to individual differences in hand and wrist postures used. While hand and wrist postures during force measurement were not monitored in this study, anecdotally, some participants measured push and pull quantities with the incorrect number of objects on the cart, which would directly lead
to error in force measurements due to incorrect loading. Additionally some participants made single measurements while others reported the averaged value of multiple measures. Where averaging multiple measures could reduce measurement error, single measurements could increase it. The ability to accurately quantify different measurement aspects of physical demands elements using field measurement tools, such as force measurement with a force gauge, has not been studied. Previous research on force gauge use has been focused primarily on force matching (Casey et al., 2002; Bao & Silverstein, 2005; Koppelaar & Wells, 2005). Large APE in force gauge measurements are likely attributable to a lack of skill in ergonomic-based measurement among the novice participants.

Height, horizontal reach, and walked distances are commonly measured with a measuring tape. For Push and Pull heights, absolute percentage errors were significantly below the threshold indicating that participants were able to measure these elements accurately. However, higher APE was observed in the Grip height, Lift/Lower height, and Reach measurements. Participants in this study were instructed to adhere to definitions for horizontal reach: distance from the mid-point of the ankles to the load centre of gravity, and height: difference between load centre of gravity at end of lift and origin of lift, where those definitions are synonymous with those described by NIOSH (1981). Subjectively, error in the horizontal reach measurement likely resulted from the participants’ inability to recall these definition points of reference for making standard measures, or as mentioned above, from using a single measurements rather than taking an average of multiple measures.

3.4.3. Practical Implications

This pilot study provides important information to those responsible for providing PDD training to novices. Firstly, these data indicate that novice observers can identify physical
demands elements accurately with standard (3 hours) training (Robins & Klitzman, 1988); however, it is possible that training may be improved by over emphasizing trainees’ attention to sensory and mobility related elements. Participants were provided with equal amounts of time on all sub-categories of physical demand elements, although their performance in identifying each class of element was not equal. Secondly, when asked to quantify aspects of each element, some novice observers were inaccurate by large margins. To improve on the accuracy of physical demand element quantification, workshop providers may want to place a greater emphasis on measurement tool use where additional practice may be necessary. Functional capacity testing relies on objective job specific information for a stronger match, and for this reason, robust measurement of job elements is crucial (Isernhagen, 2006).

The individual differences in the ability to identify physical demand elements, and more so in the ability to measure aspects of those demands raises a concern. While on average, the group identified elements with a success rate of 80%, and measured with an absolute percentage error of 10% or less most of the time, not all individual participants met the standard. Therefore, it may be prudent to suggest that a PDD should be performed by an experienced ergonomist, or at least by more than one observer when being completed by novices, as an averaged value obtained from multiple observers would help control for this error. This study only challenged observers to identify and quantify short, cyclic tasks, whereas it could be expected that error in measurement and misidentification could increase when conducting a PDD for a more complex job where tasks are non-cyclical or inconsistent, such as construction work (Bucholz et al., 1996). Important work-related decisions are rooted in PDD information so we must be confident in the quality of that data. Revisiting training and evaluation methods will be beneficial for PDD educators and practitioners moving forward to ensure the highest quality of data collection.
3.4.4. Limitations

These data are intended to provide an introductory exploration into this issue and should be interpreted in the context of the following limitations. While the PDD workshop was designed to provide targeted training on how to identify and quantify demands using a sound pedagogical approach, the training may not have been extensive enough to robustly educate the participants. This is reflected by the magnitude of error observed when quantifying many of the physical demand elements. However the length of the PDD workshop used in this study was developed to mimic the amount of time that such training methods are afforded in practice. Three-hours of targeted PDD training is consistent with time constraints allotted to undergraduate ergonomics courses and JHSC hazard assessment courses (Robins & Klitzman, 1988).

While this study provides preliminary data to suggest that novices have a limited ability to measure PDD data accurately, and are highly variable between one another, we do not know if experts are better, worse, or indifferent. In this study, we compared participant’s results to a fixed threshold in attempt to determine the accuracy of recently trained novices. However, future research should measure the performance of both experts and novices, such that the distributions can compared to better understand potential differences in the measurement abilities of the two groups. Additionally, participants were asked to identify and quantify the physical demands for jobs that they may not have been familiar with. Before a PDD, ergonomists are able to research the nature of the job they are planning to observe and often access previous PDDs on file. During observation, many uncertainties in job tasks can often be clarified by long bouts of observation as well as through conversation with the worker, where neither option was available to participants in this study. However, the goal here was to provide a preliminary understanding of the expected quality of the PDD data, as completed by novice observers following training, without adding
additional complexities such as how to professionally interact with a worker without disrupting their work.

The simulations observed represented a snapshot of each job’s tasks. These limited samples provided simple case-examples that allowed us to conduct a preliminary investigation of learning, without the added complexities of trying to evaluate a more complex work environment. For example, there was limited variability in the observed work tasks and observers were not exposed to varying environmental work conditions such as noise, worker congestion, and other distractions. However, future research can build on these findings by investigating how additional confounding factors such as job complexity and irregular duty cycles affect PDD quality during job observation by novice and experienced ergonomists.

3.5. Conclusion

This research was the first attempt to measure PDD proficiency following an introductory PDD training workshop. On average, participants were able to accurately identify physical demands elements with a success rate of at least 80%. However, as a group and individually, participants were not able to accurately quantify many of the physical demand elements required to completely describe the physical aspects of the job. To ensure that high quality job demands data is collected, PDD educators should emphasize practical hands-on training methods and develop strict evaluation criteria to help novices develop greater proficiency with measurement tools. It is believed that this research can serve both as a training and evaluation resource for educators and practitioners alike to have greater confidence in the data collection process for more robust PDDs.
3.6. References


Chapter 4 - A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work

Brendan Coffey\textsuperscript{1,2}, Renee MacPhee\textsuperscript{3}, Doug Socha\textsuperscript{4}, Steven L. Fischer\textsuperscript{1}

1 Queen’s University, School of Kinesiology and Health Studies, Kingston, ON, Canada
2 Occupational Health Clinics for Ontario Workers, ON, Canada
3 Wilfrid Laurier University, Kinesiology & Physical Education, Waterloo, ON, Canada
4 Centre for Security Science: Defence Research and Development Canada, Ottawa, ON, Canada
Abstract

Paramedics perform strenuous job tasks related to patient care and transport and as result report high rates of work-related musculoskeletal disorders (Maguire et al., 2005). Previous work has investigated the biomechanical and physiological loads associated with a subset of common paramedic tasks, however there is no research describing the total physical demand workload that paramedics are exposed to per-shift. The purpose of this research was to address this knowledge gap by characterizing the job demands of Canadian paramedics, and to compare the frequencies of the physically demanding job tasks between high-populated (HP) and low-populated (LP) services. Two paramedics from each of seven national services received six hours of training, teaching them to observe and report job demands of paramedic crews (N = 14). Paramedics completed observations while riding along with colleagues, returning their observations to the research team for further analyses. The most physically demanding aspects of paramedic work, identified by paramedics, were stretcher loading and unloading (25.6% of respondents), carrying equipment (19.5%), and pushing and pulling the stretcher (13.4%). When considering differences in task frequency between services, the empty stretcher was loaded and unloaded more frequently in HP services (10.0 ± 4.1) than in LP services (5.6 ± 3.4). Additionally medication bags were handled more frequently in HP services (21.4 ± 7.5) than in LP services (5.1 ± 3.6). This research contributes to the Canadian paramedic community by characterizing the work of paramedics and by identifying tasks perceived as the most physically demanding.
4.1. Introduction

Paramedics work in a variety of pre-hospital environments within the healthcare system from land and air ambulances, clinics, hospitals and outposts. This study focused on the physical demands of land paramedics when dispatched to emergencies within the community. Paramedics perform a range of patient care tasks including, but not limited to: critical thinking; physical assessment; management of airway obstruction; cardiopulmonary resuscitation; patient repositioning and immobilization; lifting and moving a patient; and, intravenous fluid therapy (Ontario Ministry of Health and Long Term Care, 2007). The occupation has been described as occasional bouts of high physical strain in a predominantly sedentary occupation (Gamble et al., 1991); although there is little evidence available quantifying their day-to-day demands more explicitly. However, as a result of their occasional bouts of high physical strain, paramedics report a high prevalence of stress, burnout, and fatigue (Aasa et al., 2005; Maguire et al., 2005), with recent data indicating that the injury rate of paramedics is more than seven times higher than that of the average working population (Maguire et al., 2014). Additionally, paramedics have a tendency to experience work-related musculoskeletal disorders (WMSDs) early in their career, with more injuries reported by those under the age of 30, relative to those above 30 (Hogya & Ellis, 1990). Requiring candidates to complete a standardized pre-hire physical abilities test might help to ensure that successful candidates can indeed meet the prospective job demands, which may reduce injury rates among young paramedics.

Due to the physical nature of first responders’ work, and because of concerns about public safety, candidates seeking positions within the fire department, police service, or military must first pass a pre-hire physical ability tests as a Bona Fide Occupational Requirement (BFOR). A BFOR is a condition of employment that is imposed in the belief that it is necessary for the safe,
efficient, and reliable performance of the job, and which is objectively, reasonably necessary for such performance (Canadian Charter of Human Rights, 1988). Due to the physiological and biomechanical demands associated with paramedic work (Gamble et al., 1991; Doormaal et al., 1995; Lavender et al., 2000a; Lavender et al., 2000b; Barnekow-Bergkvist et al., 2004), the high-incidence of injury among early career paramedics (Hogya & Ellis, 1990) and their critical role in public safety, the paramedic profession could benefit from the development of a pre-hire physical ability screen. Previous research has demonstrated that improving one’s physical capacity in occupational settings is associated with improved job performance and decreased workplace injuries and absenteeism (Craig et al., 1998; Williford et al., 1999; Barnekow-Bergkvist et al., 2004). By ensuring the all paramedic candidates can demonstrate the ability to meet the demands of paramedic work, paramedic services could better ensure safe and reliable job performance while also reducing risk of WMSDs to their paramedics.

Developing a physical abilities test as a BFOR is not a trivial task. As outlined by the Supreme Court of Canada in the Meiorin Decision (Supreme Court of Canada, 1999), first it must be clear that there is indeed a need for a BFOR. Using the Supreme Court’s three-part test to justify the need for a BFOR, the purpose of the standard must be rationally connected to the job; the employer must have adopted the particular standard in an honest and good faith belief that it was necessary to the fulfilment of that legitimate work-related purpose; and, the standard is reasonably necessary for the accomplishment of that legitimate work-related purpose (Supreme Court of Canada, 1999). After discussing these needs, a panel of legal, scientific and labour experts convened to identify a standard process for establishing a BFOR. As illustrated in Table 4.1 (originally presented by Gledhill & Bonneau, 2000), a 12-step process was identified to establish a BFOR in light of the Supreme Court’s decision. Considering the work of paramedics, little is known about the
critical/essential, physically demanding and frequently occurring tasks (Step 4). This remains as a barrier, preventing the development of a pre-hire physical abilities test as a BFOR for paramedics.

Table 4.1 – The systematic process required in order to establish a bona fide occupational requirement as outlined in the Meiorin Decision (Gledhill & Bonneau, 2000).

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Justify the need for a BFOR and clarify underlying issues.</td>
</tr>
<tr>
<td>2.</td>
<td>Form a project management team.</td>
</tr>
<tr>
<td>3.</td>
<td>Job familiarization including relevant professional manuals, reports and subject matter experts.</td>
</tr>
<tr>
<td>5.</td>
<td>Representative subset of physically demanding tasks.</td>
</tr>
<tr>
<td>6.</td>
<td>Characterization of tasks (simulated): time, distance, weight, measured forces etc.</td>
</tr>
<tr>
<td>8.</td>
<td>Standardization of test protocol: including consistent instruction.</td>
</tr>
<tr>
<td>9.</td>
<td>Establish scientific accuracy of test protocol.</td>
</tr>
<tr>
<td>10.</td>
<td>Develop performance standards (mean+/−SD) and Evaluate incumbent pass rate.</td>
</tr>
<tr>
<td>11.</td>
<td>a. Rationally connected to work.</td>
</tr>
<tr>
<td></td>
<td>b. Employed in good faith.</td>
</tr>
<tr>
<td></td>
<td>c. Address adverse impact, accommodation, undue hardship.</td>
</tr>
<tr>
<td>12.</td>
<td>Implement test protocol.</td>
</tr>
<tr>
<td></td>
<td>Ongoing review: to accommodate the changing workforce.</td>
</tr>
</tbody>
</table>

The physical demands of other first responders and patient care personnel are well established. Previous research has characterized job demands information obtained from hundreds of observation hours for firefighters (Bos et al., 2004), police officers (McKinnon et al., 2011), and nurses (Janowitz et al., 2006). However, while each paramedic service likely has a standard physical demands description (PDD) on file, no systematic research has been undertaken to characterize paramedics’ job demands with the same scientific rigor as that which was used to describe demands in the previously noted professions. Further, little is known about possible differences in physical demands between services, operating within the same province or between provinces. To pursue the establishment of a physical ability test as a BFOR for paramedic work, and to improve our understanding of the physical demands experienced by paramedics, a more comprehensive description of physical demands is required.
Characterizing the work of a paramedic poses many challenges. On an organizational level, patient care activities vary with each call, which can offer a unique challenge depending on the clinical status and needs of each patient. In fact, researchers have developed simulation devices to help practitioners prepare for such variance in patient care activities (Gordon et al., 1980); however, from a PDD perspective, this variability, along with the emotional stress of life-threatening calls, can pose a challenge. Due to the spontaneity of patient care activity, it is possible that a single shift observation may result in as few as one or two calls worth of physical demands data. On a personal level, paramedics work in a dynamic environment that can create mental stress depending on the nature of the call (Okada et al., 2005). In addition, an ergonomist, the professional typically responsible for conducting a PDD, may not be prepared to handle the emotional stress associated with witnessing a graphic scene such as a patient fatality. Further, some paramedic services impose strict guidelines with respect to who is permitted on a ride-out; for reasons of patient confidentiality and overall crew well-being, typically only paramedic students are routinely allowed to ride along. Due to these factors a typical job observation, as conducted by an ergonomics professional, may not be optimal.

To address these challenges and to account for patient confidentiality, paramedics can be trained to conduct physical demands observations. To prepare paramedics for this task we aimed to borrow from the participatory ergonomics model. In this model, workers are trained by ergonomics experts, empowering them to evaluate their workplace and make ergonomic recommendations and/or improvements where needed (Loisel et al., 2001; Antle et al., 2011). Where participatory ergonomics has traditionally focussed on preparing workers to evaluate ergonomic hazards, we aimed to use a similar paradigm to train paramedics on how to observe and report on physical demands. Applying this approach to train paramedics to act as observers
increases the ability to observe data over multiple shifts while controlling for challenges pertaining to mental stress and patient confidentiality.

Characterizing the job of paramedic work is a necessary component when developing a pre-hire physical abilities test as a BFOR. Using a participatory approach partnering ergonomic researchers and paramedics, the purpose of this study was to document physical demands from paramedic services across Canada and to compile these data into an overarching description of the physical demands associated with the profession. Additionally, this research aimed to identify the most physically demanding, and frequently occurring job tasks, a necessary step required for establishing a BFOR. Finally, this research aimed to contrast the frequency of highly physically demanding tasks between services based on the size of city’s population of which they served. The purpose of this distinction was to determine if the types and frequencies of physically demanding tasks differed across the country and to better understand the variability of the occupational demands which have not been empirically tested. We hypothesized that paramedics working at services in larger populations would experience a higher frequency of highly physically demanding tasks.

4.2. Methods

4.2.1. Participants:

Working in consultation with the Paramedic Chiefs of Canada (PCC) and the Paramedic Association of Canada (PAC), the project management team (co-authors) identified seven services from across the country that were invited, and agreed, to participate in the study. A total of fourteen practicing paramedics (hereafter referred to as participants), two from each of the seven services, volunteered to learn how to conduct a PDD and to observe and document physical
demands in their service. This project was approved by the University’s Research Ethics Board (Appendix E); all participants provided their informed consent.

4.2.2. Developing the Participatory Ergonomics PDD Training Model

The physical demand observation training model (Coffey et al., Chapter 3) was adapted by applying concepts from the Knowledge-to-Action Framework (Graham et al., 2006; Graham & Tetroe, 2007). In brief, the knowledge-to-action framework outlines the processes of knowledge creation; where existing knowledge is refined and tailored for the purposes of a specific end-user, and action cycle; the steps of implementing the refined knowledge into practice (Graham et al., 2006). Sinden and MacDermid (2013) used Knowledge-to-Action Framework to synthesize policy and operational knowledge of all stakeholder levels within a firefighter service to develop a PDD program. Where they were interested in occupational program development, we were interested in taking traditional PDD knowledge and revising the process and terminology to be consistent with that of paramedics. Knowledge was contextualized such that participants learned to associate physical demands vocabulary with aspects of patient care paramedic tasks. Then participants practiced applying this contextualized knowledge by watching several videos of paramedics performing job tasks and identifying the physical demands observed. This specific branch of knowledge-to-action framework is referred to as knowledge integration, which is developed through the input from end-users of tailored knowledge (Brazdil & Torgo, 1990). By consulting with and requesting feedback from participants, or end-users, we were able to strengthen the training workshop and streamline data collection.

Participants were trained using a previously evaluated PDD training workshop (Coffey et al., Chapter 3) based on the PDD Handbook, published by the Occupational Health Clinics for Ontario Workers (n.d.). The training guided learners through a three-step process: preparation,
observation and data collection, and reporting, for completing a PDD. The PDD training workshops (slide deck provided in Appendix C) were 6 hours in length where all content was tailored to the physical demands associated with common paramedic patient handling and activity tasks using the knowledge-to-action cycle framework. This workshop was twice the total duration of that used in Chapter 3 due to willingness and availability of the participant population. A snapshot from one of the participatory PDD workshops is illustrated in Figure 4.1

![Figure 4.1 - The research team and participants working through the PDD workshop](image)

Although a PDD requires evaluators to normally complete all three steps, participants in this study were only responsible for identifying the frequency and duration of physical demands occurring during their observation sessions. Previous research (Coffey et al., Chapter 3) has indicated that novice observers can accurately identify physical demands but, often struggle with accurately measuring variables associated with each demand, such as forces and weights. To account for this, equipment weights were measured by the research team, while patient demographics (e.g., age, weight, height) were gathered by participants through consultation with
patients during job observations. Participants were also responsible for quantifying the number of stairs ascended and descended and to estimate the distance travelled walking to and from calls with and without the stretcher. Participants were provided with a standardized data recording booklet (Appendix D) to provide a space for their observations, including reminders to help paramedics identify, classify and report on physically demanding elements in accordance with the methods they learned during the training.

4.2.3. Research Design

An iteration of the Knowledge-to-Action cycle was completed by first piloting the PDD training workshop at two services: ON-Central and ON-East. Following a debriefing meeting with participants from the pilot services, the PDD training and resources were updated, to better reflect examples and terminology commonly used by the paramedic profession. Using the updated training and resources, PDD training was administered at five additional paramedic services across Canada: West, ON-North, ON-South, East-1, and East-2 (Figure 4.2). After completing training, each PDD trained participant was responsible for two full-shift ride-out observations. Participants recorded data and returned the completed PDD booklets to the research team. The specific names and locations of the paramedic services have been purposely omitted to protect their anonymity.
4.2.4. Data Analysis:

Data collection booklets were transcribed and complied into a central spreadsheet. Aggregate data from each service were used to determine the frequency and duration of all physical demands observed and call information reported, per shift. Once all data were transcribed, descriptive statistics – mean and standard deviation – were calculated for all observed physical demands tasks and for all call information from each service.

4.2.5. Statistical Analysis:

Differences in physical demands between paramedic services were considered on the basis of the size of the population they served. Services were assigned to the High-Population (HP) group if they served cities that were among the top 20 metropolitan populations as determined by data from the Canada 2011 Census (Statistics Canada, 2012). Services were assigned to the Low-Population (LP) group if they served cities that were not included on that list. East-1, West, and ON-South were categorized into the HP group, and ON-North, ON-East, ON-Central, and East-2 were categorized into the LP group.
Following the completion of each observed call, participants asked attending paramedics to indicate what aspect of that call was most physically demanding. Comparisons between HP and LP services were then made considering only the per shift values for the tasks most often identified as the most physically demanding. For task data with equal variances, as determined by a Levene’s test $p$-value $\geq .05$, a one-way between groups analysis of variance (ANOVA) was performed comparing the HP and LP means. To determine the effect size for ANOVA findings, $\eta^2$ was calculated (Cohen, 1988) where a $\eta^2$ value of .10 represents a small effect, .25 a medium effect, and .40 a large effect (Cohen, 1992). For task data with unequal variances, as determined by a Levene’s test $p$-value $\leq .05$, a one-way between groups Kruskal-Wallis test, the non-parametric equivalent of an ANOVA, was performed. To determine the effect size for the Kruskal-Wallis findings, Pearson’s $r$ was calculated (Rosenthal, 1991) where an $r$ value of .10 represents a small effect, .30 a medium effect, and .50 a large effect (Cohen, 1992). All statistical testing was conducted using IBM SPSS Statistical Software (Armonk, NY, USA).

4.3. Results

4.3.1. Descriptive Statistics: Time spent on call and patient demographics

All shifts documented were 12 hours (720 minutes) in length. Descriptive statistics are reported for each call, where calls were further divided into specific “call components” (Table 4.2). A call begins from the time paramedics are dispatched until the call is either terminated or a transfer of patient care at the final destination has occurred (e.g., hospital, nursing home, patient’s home). “Dispatch to call” refers to the amount of time spent in transit in the ambulance travelling to the scene of a call following notification from the ambulance dispatcher. “At the scene of call” is measured from the time paramedics arrive on scene until they depart. “Scene to destination” refers to the amount of time spent in transit driving the ambulance from the scene to final
destination with the patient. “Offload delay” is a measure of the time spent within a hospital waiting for the transfer of patient care to hospital staff. Using these classifications, call specific information regarding the mean number of calls observed per shift at each location and amount of time spent performing each of the identified job activities per shift were identified. “Off call” refers to the total amount of time per shift when paramedics are not actively involved with a patient in any of the aforementioned call components. Participants indicated that this time could have been spent driving the ambulance roaming through their catchment area, seated in the ambulance or in a satellite station awaiting a call, or cleaning and restocking the rear compartment of the vehicle. Data for all descriptive statistics are presented in order of decreasing annual call frequency. Additionally, patient demographics – age, weight, and height, were recorded for each call (Table 4.3). Variability in patient demographics was high, where large ranges were observed between services in age – 1 to 100 years, weight – 12 to 150 kilograms, and height – 60 to 190 centimetres.

Table 4.2 - Call frequency and component durations stratified by service. Calls observed data represents the mean frequency of calls observed per shift and accompanying standard deviation, in parentheses, based on samples obtained from each site. All other data represent the mean duration per shift of the call components in minutes and accompanying standard deviation, in parentheses, based on samples obtained from each site.

<table>
<thead>
<tr>
<th>Service</th>
<th>Calls Observed</th>
<th>Dispatch to call</th>
<th>At scene of call</th>
<th>Scene to destination</th>
<th>Offload delay</th>
<th>Off-call time</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-1</td>
<td>6 (0)</td>
<td>53 (5.7)</td>
<td>118.5 (19.1)</td>
<td>73 (32.5)</td>
<td>75 (49.4)</td>
<td>400.5</td>
</tr>
<tr>
<td>West</td>
<td>8.5 (2.5)</td>
<td>59 (21)</td>
<td>81.5 (13.9)</td>
<td>54.3 (40.8)</td>
<td>100 (6.7)</td>
<td>425.2</td>
</tr>
<tr>
<td>ON-South</td>
<td>5 (2.3)</td>
<td>33.8 (13.4)</td>
<td>96.6 (49.9)</td>
<td>35.6 (19.2)</td>
<td>91.6 (48.7)</td>
<td>462.4</td>
</tr>
<tr>
<td>ON-North</td>
<td>3.5 (1.2)</td>
<td>29.5 (7)</td>
<td>52.5 (14.2)</td>
<td>37.7 (9.5)</td>
<td>12 (8.8)</td>
<td>588.3</td>
</tr>
<tr>
<td>ON-East</td>
<td>4.75 (1.8)</td>
<td>32.3 (10.7)</td>
<td>66 (32.5)</td>
<td>31 (6.8)</td>
<td>52.5 (19.1)</td>
<td>538.2</td>
</tr>
<tr>
<td>ON-Central</td>
<td>2.75 (1.7)</td>
<td>32.5 (35.1)</td>
<td>45 (27.2)</td>
<td>37.8 (30.2)</td>
<td>20 (28.3)</td>
<td>584.7</td>
</tr>
<tr>
<td>East-2</td>
<td>3 (1.4)</td>
<td>18.5 (10.7)</td>
<td>47.3 (38.7)</td>
<td>31.8 (27.8)</td>
<td>13 (11.3)</td>
<td>609.4</td>
</tr>
</tbody>
</table>
Table 4.3 – A summary of patient demographic information based on the calls observed. Data represents the mean and standard deviation, in parentheses, based on the samples obtained from each service.

<table>
<thead>
<tr>
<th>Service</th>
<th>Age – years</th>
<th>Weight – kg</th>
<th>Height - cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-1</td>
<td>57.5 (25.6)</td>
<td>65.3 (12.0)</td>
<td>163.6 (14.4)</td>
</tr>
<tr>
<td>West</td>
<td>53.4 (21.7)</td>
<td>67.8 (23.2)</td>
<td>162.5 (24.9)</td>
</tr>
<tr>
<td>ON-South</td>
<td>52.1 (27.7)</td>
<td>67.6 (16.7)</td>
<td>163.2 (25.4)</td>
</tr>
<tr>
<td>ON-North</td>
<td>61.2 (25.9)</td>
<td>81.9 (25.9)</td>
<td>168.7 (7.9)</td>
</tr>
<tr>
<td>ON-East</td>
<td>55.3 (23.5)</td>
<td>78.4 (25.9)</td>
<td>161.7 (24.6)</td>
</tr>
<tr>
<td>ON-Central</td>
<td>48.8 (24.2)</td>
<td>77.8 (37.9)</td>
<td>162.0 (23.1)</td>
</tr>
<tr>
<td>East-2</td>
<td>53.5 (30.0)</td>
<td>70.7 (34.5)</td>
<td>167.1 (11.4)</td>
</tr>
</tbody>
</table>

4.3.2. Physical Demands from Seven Paramedic Services Selected from Across Canada:

Paramedics are responsible for transferring and transporting patients, while on-scene and from the scene to the ambulance. When a patient has limited mobility and/or is unconscious, these tasks occur with the aid of a stretcher. When using the stretcher, paramedics are required to load (lift into ambulance) and unload (lower out of ambulance) the stretcher without a patient (black bars in figure below), and with a patient (grey bars in figure below) into and out of the rear compartment of the ambulance. Paramedics are also required to raise or lower the stretcher without a patient (diagonally striped bars in figure below), and with a patient (horizontally striped bars in figure below) to specific target heights when loading, transferring, or moving patients. The frequency of stretcher transferring and transporting tasks is reported in Figure 4.3. Data for the stretcher raise/lower task were intentionally left hollow for East-1 and ON-North as both service use battery-operated hydraulic stretchers which raise and lower the stretcher to selected heights by pressing a button, eliminating physical demand requirements. Additionally, data for the load/unload stretcher task from the ambulance were left hollow for ON-North as their ambulances have cot fastener systems installed which automatically load and unload the stretcher. Data from
these services were omitted from further statistical comparison. The weights of stretchers and other patient transfer equipment used within each service are reported in Table 4.4.

![Graph of frequency of stretcher lift & lowering tasks per shift, stratified per service. Error bars indicate standard deviations. Note: PT is an abbreviation for "patient".]

**Table 4.4 Patient transfer equipment weight in kilograms.**

<table>
<thead>
<tr>
<th>Service</th>
<th>Stretcher</th>
<th>Stair Chair</th>
<th>Spinal Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-1</td>
<td>72.9*</td>
<td>15.9</td>
<td>5.3</td>
</tr>
<tr>
<td>West</td>
<td>48.9</td>
<td>18.5</td>
<td>9.8</td>
</tr>
<tr>
<td>ON-South</td>
<td>50.1</td>
<td>15.9</td>
<td>8.1</td>
</tr>
<tr>
<td>ON-North</td>
<td>72.9*</td>
<td>10.0</td>
<td>6.1</td>
</tr>
<tr>
<td>ON-East</td>
<td>45.2</td>
<td>18.5</td>
<td>8.2</td>
</tr>
<tr>
<td>ON-Central</td>
<td>45.2</td>
<td>18.5</td>
<td>8.2</td>
</tr>
<tr>
<td>East-3</td>
<td>48.9</td>
<td>18.5</td>
<td>6.3</td>
</tr>
</tbody>
</table>

In order to provide patient care, paramedics are required to lift and carry a variety of equipment to and from calls. While all services use similar types of patient care supplies, specific weights of paramedic equipment (Table 4.5) varied between services based on how medical supplies were packaged and depending on what make and model of bag was used. Three pieces
of equipment however were uniformly bundled and brought to almost every call across all services; cardiac monitor (black bars – used to measure physiological vital signs), airway bag (grey bars – used to carry tools to intubate and monitor airways), and the medication bag (diagonally striped bars – used to carry intravenous catheters, syringes, medication, etc.).

Frequency of medical equipment lifting and carrying is presented in Figure 4.4.

Table 4.5 Patient care equipment weight in kilograms of three common items handled across all services: cardiac monitor, airway bag, and medication bag.

<table>
<thead>
<tr>
<th>Service</th>
<th>Cardiac Monitor</th>
<th>Airway Bag</th>
<th>Medication Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-1</td>
<td>11.2</td>
<td>6.9</td>
<td>1.4</td>
</tr>
<tr>
<td>West</td>
<td>12.5</td>
<td>7.0</td>
<td>9.5</td>
</tr>
<tr>
<td>ON-South</td>
<td>12.0</td>
<td>6.2</td>
<td>11.4</td>
</tr>
<tr>
<td>ON-North</td>
<td>11.0</td>
<td>6.1</td>
<td>6.9</td>
</tr>
<tr>
<td>ON-East</td>
<td>13.3</td>
<td>11.8</td>
<td>9.6</td>
</tr>
<tr>
<td>ON-Central</td>
<td>13.3</td>
<td>11.9</td>
<td>14.1</td>
</tr>
<tr>
<td>East-2</td>
<td>11.0</td>
<td>11.4</td>
<td>7.7</td>
</tr>
</tbody>
</table>

Figure 4.4 - Frequency of patient care equipment lifting, carrying & lowering per shift, stratified per service. Error bars indicate standard deviations.
Paramedic work is dynamic and regularly requires travelling on foot in order to assess and provide patient care. When transporting a patient, paramedics work in tandem to push and pull the stretcher to and from the ambulance. The demand of this task is dependent on the weights of patient (Table 4.3) and stretcher (Table 4.4), but also the environment (i.e. more demanding when pushing/pulling through snow or uphill when compared to smooth flat pavement). Mean distances of stretcher pushing and pulling per shift are reported in Figure 4.5.

![Figure 4.5 - Mean distances of stretcher (with patient) push/pulled per shift, stratified per service. Error bars indicate standard deviations.](image)

Paramedics complete a variety of patient transferring and repositioning tasks where they may manually lift a patient vertically, horizontally, or rotationally in an assisted patient stand and pivot maneuver. Additionally paramedics also use a stair chair and spinal board when lifting and transferring immobile patients up and down stairs, or in tight spaces where the stretcher cannot be maneuvered. The frequency of these activities are reported in Table 4.6.
Table 4.6 - Lifting demands per shift stratified per service. Data represents the mean and standard deviation frequency based on samples obtained from each service. Note: PT is an abbreviation for “patient”.

<table>
<thead>
<tr>
<th>Service</th>
<th>Vertical PT Lift</th>
<th>Horizontal PT Transfer</th>
<th>Assisted PT Stand &amp; Pivot</th>
<th>Loaded Stair Chair Lift &amp; Carry - stairs</th>
<th>Loaded Spinal Board Lift &amp; Carry - stairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-1</td>
<td>5.5 (0.7)</td>
<td>4.5 (3.5)</td>
<td>1.5 (0.7)</td>
<td>20 (22)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>West</td>
<td>1.5 (1.9)</td>
<td>1.0 (1.4)</td>
<td>1.7 (1.7)</td>
<td>6.2 (7.5)</td>
<td>1.25 (2.5)</td>
</tr>
<tr>
<td>ON-South</td>
<td>2.2 (1.5)</td>
<td>3.2 (1.5)</td>
<td>2.4 (1.5)</td>
<td>5.4 (8.3)</td>
<td>2.4 (5.3)</td>
</tr>
<tr>
<td>ON-North</td>
<td>2.0 (1.4)</td>
<td>4.0 (2.2)</td>
<td>2.0 (1.4)</td>
<td>9.5 (10.5)</td>
<td>6.0 (9.5)</td>
</tr>
<tr>
<td>ON-East</td>
<td>2.0 (1.6)</td>
<td>3.5 (1.9)</td>
<td>2.0 (1.8)</td>
<td>23.2 (22.5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>ON-Central</td>
<td>2.5 (2.5)</td>
<td>2.0 (1.6)</td>
<td>3.25 (2.9)</td>
<td>17 (17.7)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>East-2</td>
<td>1.0 (1.1)</td>
<td>3.25 (2.6)</td>
<td>1.25 (1.25)</td>
<td>5.5 (6.4)</td>
<td>1.25 (2.5)</td>
</tr>
</tbody>
</table>

Mobility related demands varied between services (Table 4.7). Depending the location of a call and the geographical layout of the region and/or hospital, paramedics were required to walk up to 749.2 ± 599.2 metres in the West service, or as little as 105.8 ± 113.6 metres in the ON-Central service. At many call locations, especially residential houses and/or older buildings without elevators, paramedics are required to ascend and descend stairs to provide patient care and transportation. Paramedics were required to ascend and descend the most stairs in East-1 – 116.5 ± 74.2, and the least number of stairs in East-2 – 22.5 ± 14.7.

Table 4.7- Mobility demands stratified per service. Data represents the mean and standard deviation frequency based on samples obtained from each service.

<table>
<thead>
<tr>
<th>Service</th>
<th>Walked Distance</th>
<th>Stairs Ascended &amp; Descended</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-1</td>
<td>470 (168.8)</td>
<td>116.5 (74.2)</td>
</tr>
<tr>
<td>West</td>
<td>749.2 (599.2)</td>
<td>77 (39.5)</td>
</tr>
<tr>
<td>ON-South</td>
<td>276.4 (67.6)</td>
<td>48.8 (52.3)</td>
</tr>
<tr>
<td>ON-North</td>
<td>287.5 (136.7)</td>
<td>32.7 (30.2)</td>
</tr>
<tr>
<td>ON-East</td>
<td>407.5 (245.3)</td>
<td>27.6 (25.2)</td>
</tr>
<tr>
<td>ON-Central</td>
<td>105.8 (113.6)</td>
<td>39.6 (43.2)</td>
</tr>
<tr>
<td>East-2</td>
<td>398.7 (359.5)</td>
<td>22.5 (14.7)</td>
</tr>
</tbody>
</table>
4.3.3. Most Physically Demanding Tasks Reported by Paramedics

At the end of each call observed, paramedics were asked to identify the “most physically demanding task” of that specific call. Responses were not prompted, allowing paramedics to choose any task they perceived as most physically demanding. The most frequently identified tasks were: stretcher loading and handling (25.6% of responses), carrying patient care equipment (19.5%), and stretcher pushing and pulling with patient (13.4%) (Figure 4.6). Tasks labelled as “Other” (7.3%) included: working in the rear of ambulance, driving, vehicular patient extrication, kneeling, trying to assess a combative patient, and entering and exiting the ambulance.

![Figure 4.6 - Breakdown of the most physically demanding perceived tasks, as reported at the end of each call.](image)

4.3.4. Comparing the Frequency of Exposures to High Demand Tasks of Low- and High-Population Services

Service data were categorized as HP or LP based on the size of the population they serviced. Comparisons were only performed considering the most physically demanding tasks, as reported by paramedics (Figure 4.6).
When using the stretcher, paramedics in HP services loaded and unloaded an empty stretcher more frequently than those in LP services (Figure 4.7). A one-way ANOVA revealed the difference in frequencies of the stretcher loading and unloading without patient task between HP services \((M = 10.09, SD = 4.08)\) and LP services \((M = 5.58, SD = 3.44)\) to be significant, \(F(1,21) = 8.22, p = .009, \eta^2 = .281\). No other significant differences in stretcher manipulation task frequencies were detected. Data from services that use battery-operated hydraulic stretchers that reduce the paramedics’ effort for these tasks (i.e., East-1: stretcher raise/lower, and ON-North: stretcher raise/lower and load/unload) were excluded from this comparison.

![Figure 4.7 - Comparison of mean frequency of stretcher manipulation tasks per shift, between HP and LP services. Error bars indicate standard deviations. Note: Asterisk (*) represents a significant difference in means \((p \leq 0.05)\).](image)

Regarding patient care equipment, paramedics in HP services carried the medication bag more frequently than LP paramedics (Figure 4.8). A Kruskal-Wallis one-way ANOVA revealed difference in medication bag handling frequencies between HP services \((M = 21.36, SD = 7.48)\) and LP services \((M = 5.06, SD = 3.58)\) to be significant, \(H(1) = 18.32, p < .001, r = .58\). No difference was found between HP and LP services for cardiac monitor and airway and handling. A
comparison of stretcher pushed and pulled distance (with patient) revealed no difference between HP and LP services (Figure 4.9).

Figure 4.8 - Comparison of mean patient care equipment lifting, carrying & lowering, per shift, between HP and LP services. Error bars indicate standard deviations. Note: Asterisk (*) represents a significant difference in means (p ≤ 0.05)

Figure 4.9 - Comparison of mean stretcher pushing and pulling distances per shift between HP and LP services. Error bars indicate standard deviations.
4.4. Discussion

4.4.1. Physical Demands of Canadian Paramedics

A paramedic shift can often consist of long periods of sedentary activities, typically spent driving in a defined catchment area. In each service sampled, paramedics spent on average at least half of their 12-hour shift durations “off-call”. Sedentary activities are interspersed with bouts of patient care, sometimes requiring intense physical demands; however, the types of call that are responded to within each shift and the associated physical demands will vary. For example, the calls observed in this study included cardiac events, motor vehicle accidents and a stabbing, where the associated physical demands were dependent on the situation, mobility, location, and status of the patient. While these day-to-day activities are quite diverse, in nearly every service (greatly reduced in those with powered stretchers), a number of common physical demands elements including lifting, lowering, and carrying are common. Despite the diversity between calls and services, lifting is an essential demand in many aspects of paramedic work.

Lifting is a requirement for many common paramedic tasks (Lavender et al., 2000a; Lavender et al., 2000b). When responding to calls where a patient is immobile, lifting is necessary in order to transfer him/her onto a stretcher or a stair chair, potentially during the move towards the ambulance, and then into the rear compartment of the ambulance. Factors such as the accessibility of a scene, patient weight, and state of a patient (i.e., whether they are compliant, combative, conscious, etc.), can influence the difficulty of this task as identified by paramedics anecdotally. A typical call may consist of several lifts, where the demands of each lift can range from 1.4 kg when lifting a light medical bag to upwards of 200 kg when team lifting a powered stretcher (72.9kg) with a heavier patient (190kg) up and over a curb, for example. While the frequency of lifting varied between shifts and services, even single lifting exposures of these
combined weights are strenuous. In almost every call paramedics were required to lift a load in excess of the 23kg load constant proposed in the NIOSH Lifting Equation as the maximum weight for a lift under the most ideal conditions (Waters et al., 1994). While the act of moving patients poses a challenge when aiming to “reduce the load”, at a minimum a pre-hire physical abilities test would be beneficial to ensure that potential candidates can meet these strenuous lifting demands. If a candidate cannot meet these demands safely there are important safety risks to paramedics and patients alike.

4.4.2. Most Physically Demanding Tasks Reported by Paramedics

The most physically demanding tasks identified by paramedics in this study differ from previous literature. Results of a survey by Lavender et al. (2000b) identified the following list of most physically demanding job tasks: horizontal transfer from bed to stretcher using a bed sheet; horizontal transfer from stretcher to hospital gurney using a bed sheet; and, carrying a patient downstairs using a backboard, stretcher, or stair chair. In contrast, the most difficult tasks identified in the present study were related to stretcher and equipment handling. These differences may be related to different paramedic infrastructures between countries as Lavender et al. (2000b) surveyed a group of American paramedics. In the United States, paramedics (also referred to as Emergency Medical Technicians [EMTs]) and firefighters often work in tandem, sometimes out of the same station. This partnership can allow for more available help in patient lifts and stretcher loading and unloading. However in Canada, firefighting and paramedic services are mostly independent entities that may overlap depending on the nature of the call, reducing opportunities for joint paramedic-firefighter teamed lifting. Given the difference in how emergency response services are typically organized between countries, it is likely that Canadian paramedics identify stretcher loading and unloading as the most physically demanding task as
there are usually only two paramedics performing the lift and lower, whereas American EMTs often have additional assistance.

4.4.3. Comparison of Low-Population and High-Population Services

Two key differences emerged when comparing physical demand elements between services working in high- and low-populated regions. Paramedics working in high-populated services loaded and unloaded an empty stretcher and handled medication supply bags more frequently. As high-populated services responded to more calls, their paramedic crews tend to handle this equipment more often. While Patient Care Standards policy indicates that paramedics are only required to bring the stretcher to every trauma and cardiac arrest call (Ministry of Health and Long-Term Care, 2007), anecdotally, paramedics indicate that this practice is adhered to for the majority of calls, regardless of patient category. Indeed this ensures that paramedics are properly equipped for many situations. However, the caveat is that it results in greater physical demand exposures. Based on data from this study, bringing all equipment to the patient negatively affect paramedics in high-populated regions, requiring them to lift, carry, push, and pull in greater repetition thus increasing their cumulative workload.

4.4.4. Participatory Ergonomics Approach to Documenting Paramedic Work

This study was the first attempt to characterize the physical demands of paramedic work in Canada. This novel approach led to a substantial compilation of paramedic physical demands data while also meeting the Canadian National EMS Research Agenda (Jensen et al., 2013) objective to conduct research in partnership with the Canadian paramedic community. By working in partnership with Canadian paramedics we were able to design a research methodology that allowed for data to be gathered from several services, dispersed geographically, in a relatively
small time frame. Additionally, research partnerships with the paramedic community allows for a clearer interpretation of the results, leading to best informed knowledge-to-action decisions.

4.4.5. Practical Implications

The frequency and perceived physical demands associated with carrying and moving patient care supplies identifies a key opportunity for intervention. Health care governing bodies in Canada, such as Ontario, have Provincial Equipment Standards and Patient Care Standards for Ontario Ambulance Services (Ministry of Health and Long-Term Care, 2007; Ministry of Health and Long-Term Care, 2011). These are legislated requirements for the type of supplies that must be stocked in patient care bags, and the patient care supplies that must be brought to the patient upon arrival at each type of call, respectively. While different services have employed strategies to attempt to bundle equipment for more efficient transport and use, the total weight of supplies that is handled remains high. Additionally, despite aforementioned policy regulations, paramedics tend to bring all equipment to calls regardless of the patient’s call type category. On one hand, bringing an abundance of equipment to each scene allows paramedics to deliver a variety of care based on the medical situation and can save time by limiting multiple trips to and from the ambulance. However, as described anecdotally by paramedics, many calls do not require the use of some, or any of this equipment (e.g., ambulatory patient, refusal of care, etc.). Regardless they are required to carry it, in some cases for long distances, where the associated demands are increased further when carrying equipment into buildings with multiple flights of stairs. Considering the physical demands associated with frequently handling patient care equipment, these results suggest that paramedic leaders and policy makers should revisit how equipment standards are established and how these policies are adhered to in practice. Physical demands exposures of paramedics could be reduced by revising existing practices such that patient
care and safety can be maintained, in addition to paramedic health and wellbeing such as imposing weight limits that can be carried to and from calls or decreasing the weight of commonly used equipment bags.

The documented exposure of physical demands can be used for future job interventions. While PDDs likely exist for many paramedic services across Canada, the dataset compiled in this research is based on much larger volume of shift observations (n= 26). On a broad level it is important to consider the physical demands of an occupation as it can directly relate to compensation costs for injuries in the workplace (Jones et al., 2005). Workplace insurance providers will refer to information within a PDD, such as frequency and duration of tasks, when reviewing worker compensation claims to determine whether an injury is work-related. More specifically, paramedic employers can use this information to gauge the physical demands that their employees are exposed to and seek opportunities to revise practices around transporting patient care equipment. Additionally ergonomic professionals working with paramedic populations can refer to this data as a preliminary source in identifying WMSD hazard risks, such as the frequency and magnitude of lifting, prior to making task-related recommendations.

These data also provide a foundation from which to develop a physical abilities test as a BFOR to work as a paramedic. Paramedics perform job tasks in the same environment and under similar emergency-based situations as other public safety professionals (e.g., firefighters, military personnel, police); however, paramedics remain without a scientifically validated physical abilities test as a BFOR. Establishing a culture of improved fitness and increasing physical capacity within work communities has been shown to decrease sick leave incidents and increase job performance (Williford et al., 1999; Barnekow-Bergkvist et al., 2004) while lowering workplace accidents (Craig et al., 1998). The introduction of a validated BFOR into the
paramedic profession, based on these foundational PDD data, could assist in further developing the fitness culture within the paramedic profession.

4.4.6. Limitations

These data represent the physical demands of paramedic work; however, they should be interpreted within the following considerations. Data were collected by subject matter experts in paramedicine, as guided by experts in ergonomics. This is opposite of common practice and it is possible that paramedics may have misrepresented some physical demand elements. In order to account for this novel participatory ergonomic approach to job observation, the research team took several precautions including: standardizing the PDD workshop design and content at each paramedic service such that all paramedic observers were educated consistently with the same practical simulations; equipping participants with the same measurement tools (aside from minor language modifications made following feedback from the pilot services); and, utilization of the same data collection template. While this approach has not been previously validated in ergonomics literature, based on consultation with paramedics and management in paramedics services, it was deemed to be the most ethical and inclusive approach to account for patient confidentiality while protecting a standard ergonomic observer from mental stress of graphic events.

4.5. Conclusion

Paramedics are exposed to physically demanding tasks interspersed between bouts of sedentary-like activities. On a daily basis, paramedics are subjected to doses of lifting, carrying, pushing and pulling, which they often identify as being the most demanding elements of their job. Additionally, paramedics working in services responding to calls in HP areas load and unload an
empty stretcher and carry patient care equipment bags more frequently than their LP serving counterparts. It is likely that paramedics routinely bring the stretcher and patient care equipment to the side of each patient (as per standard practice in some areas); although, actual patient care activities do not always require the stretcher or the use of some patient care equipment. Since HP services respond to more call per shift, the HP vs. LP comparison has revealed the potential negative physical effect of these types of standard practices, exposing paramedics (more so in HP services) to unnecessary physical demands. Paramedics provide a critical medical service to communities across Canada and while much still remains unknown regarding the intricacies of paramedic work, this research is a first step in better understanding the demands of the profession. By actively involving paramedics in the research process this study has helped to further promote the culture of ergonomics research within the paramedic community, paving way for future projects aimed at improving the knowledge base of physical demands and capacities within the profession.
4.6. References


Chapter 5 - General Discussion

5.1. Summary of Key Findings

Physical demands data are used for many job-related decisions. PDD data are relied on when first creating or establishing a position, during the job hiring and screening process, to aid in job training, as a basis for defining job hardening and matching activities in return-to-work scenarios, and when adjudicating worker compensation claims. In order to make evidence informed decisions, objective, high quality PDD data is essential. The research outlined in Chapter 3 measured the effectiveness of PDD training by observing novices’ ability to accurately identify and quantify physical demand elements. The interactive workshop approach used to deliver PDD knowledge is common, but prior to this study, its effectiveness on novices’ learning had not been documented. Our results suggest that novice observers can adequately identify physical demands elements, but fail to accurately apply measurement tools to quantify dimensions associated with those elements, following PDD workshop training.

While this research offers specific observations regarding how accurately physical demand elements can be identified and measured by novice learners, just as importantly, it also communicates the importance of quality PDD training and evaluation methods. Many different templates and methods for collecting PDD exist; and, as a result there is a lack of uniformity among practitioners. As the PDD is used and relied on in practically every job sector, the ability to be adaptable and customizable is undoubtedly a strength. Yet it remains important to ensure that adequate training results in accurate data collection and reporting. It is our intention that ergonomic practitioners can refer to this research as an example of how to either implement or
improve their current model of PDD training and evaluation in order to increase our collective confidence in physical demands data that is routinely collected.

The research outlined in Chapter 4 provides a description of the physical demands associated with paramedic work in Canada. Data reflect physical demand exposures across seven paramedic services, including ranking the most physically demanding tasks experienced on a per shift basis as perceived by paramedics. Additionally, we have investigated how the frequency of highly physically demanding tasks varies based on the size of the population served by each paramedic service. This research provides a foundation for future paramedic research by improving our understanding of the physical demands, and variability in demands, associated with the profession. Relying on these results, researchers can move towards the development of a physical abilities test as a BFOR for Canadian paramedics.

5.2. Strengths

This research addresses gaps in our knowledge about the effectiveness of PDD training, and about our understanding of the physical demands associated with paramedic work. While the PDD is an essential tool in ergonomic practice, no research prior to that presented in Chapter 3 has attempted to measure or evaluate how trainees perform aspects of a PDD following training. Training was targeted towards novice observers, as the PDD is commonly used in the field by early career ergonomists and JHSC members. Previous research has focused on the analysis of specific aspects of paramedic task requirements, such as WMSD occurrence (Maguire et al., 2005; Maguire et al., 2014) and the biomechanics of lifting (Lavender et al., 2000a; Lavender et al., 2000b), however Chapter 4 is the first to thoroughly capture the overarching physical demands of paramedic work. Both manuscripts present valuable information that can be applied to inform ergonomic practices.
Chapter 4 employed a participatory ergonomic approach to data collection with paramedics. This partnered approach allowed for collaboration between the research team and paramedic community to structure a research design with input from both sides. By doing so, clear goals were established and valuable, mutually beneficial objectives were identified and met. The participatory approach used in this research was largely successful due to the implementation of Knowledge-to-Action Framework. Following knowledge creation and action cycle pathways, paramedics were able to apply their existing knowledge to customize the PDD process in order to observe and identify the physical demands associated with their paramedic tasks, allowing us to capture a large dataset of job demands information. This collaborative approach could likely be applied in any industry to build research relationships and capture job demands data.

5.3. Limitations

5.3.1. Chapter 3

A limitation common to both research manuscripts in this thesis relate to the population sampled. In Chapter 3, while close to 40 undergraduate students attended the PDD training workshops lectures, only ten participants volunteered to participate in the study. Ideally a larger sample size would have volunteered, affording us greater statistical power and confidence in the results. However, given the novelty of this research topic, these findings provide valuable preliminary evidence regarding the effectiveness of PDD training for ergonomic practitioners and educators.

5.3.2. Chapter 4

In Chapter 4, while the sample size was large when considering the number of work hours observed (n = 312), financial constraints limited the number of services that could be recruited.
While it was noted that most of the seven paramedic services had rural catchment areas, all participating services were located in cities with populations at or above 100,000. It is possible that in smaller and more isolated services, a different subset of physically demanding tasks, performed at different frequencies, may have been observed. Additionally, as there is not a well-defined metric to define “high” and “low” populated areas, the distinction was chosen by the research team for an even distribution of service physical demands data.

Paramedic participants were trained to collect physical demands data, a task typically performed by ergonomists, which may affect data quality. To reduce the effect of this limitation we developed research methodology based on the findings from Chapter 3 which indicated that novice observers could accurately identify physical demands but not quantify them. Based on these findings we took precautions to support the collection of quality data by only asking participants to observe and identify the physical demands of paramedic work. While we used findings from Chapter 3 as a validation for the workshop approach which was then applied in Chapter 4, it should be noted that paramedics and university students are separate populations with differing backgrounds in education. Despite this, neither group had previous knowledge or experience with the PDD prior to respective workshops thus we assumed that the ability for student population to accurately identify physical demands could translate to the paramedic population. Finally, the ergonomic research team made the necessary physical demand measurements to avoid error from inexperienced participants.

5.4. Future Research Directions

5.4.1. Chapter 3

Job simulations were purposely chosen to be short in duration in order to maximize
recruitment by addressing the time availability constraints of participants. Simulations lasted between 1-3 minutes in length and were meant to represent a segment of a worker’s overall job. While condensed job simulations allowed for the control of physical demand element occurrence and measurements, it is possible that results may not reflect a true PDD activity when observing the same tasks over the course of a full work day. Over the course of a full work-shift some variability in job tasks may exist which expose the worker to different physical demand elements. It is recommended that future research efforts aim to evaluate how trainees conduct PDDs using longer job simulations, or live jobs, to account for job variability.

Results from the physical demand element identification task illustrated that different sub-categories of physical demands elements (strength, mobility, hand-activity, sensory) were identified with varying accuracy. Future research should focus on the ability to identify different sub-categories to better understand the preliminary findings from this study. Future research on this topic may help to determine if physical demand elements are more difficult to identify based on sub-category, or if more targeted training is required.

5.4.2. Chapter 4

The purpose of this research was to characterize the physical demands of paramedic work. Of the large subset of physical demands information collected, data mostly pertained to gross motor skill demands associated with common paramedic tasks such as lifting, carrying, pushing, pulling, and walking. Future work should attempt to capture demands with a greater emphasis on fine motor skill demands and dexterity such as pinching and gripping. These demands can be difficult to identify and quantify as they can occur seamlessly at the scene (e.g., patient restrains) and during transit in the rear of the ambulance (e.g., intravenous starts) where confined spaces make them difficult to observe/measure. Performance of these demands are critical in various
life-saving and life-sustaining situations thus more detailed data can benefit future research
endeavours.

Data collection for this study was primarily aimed at capturing the demands observed while
paramedics were on the scene of a call or in transit to and from a call. While information
regarding pre-shift activities were recorded, considering the amount of “off-time” experienced by
paramedics, more detailed analysis of what paramedics do during down time between calls is
important in understanding the demands and activities of an entire shift. Call activity data
indicates that paramedics typically spend at least half of their shift not occupied with call-related
activity. While a general understanding of activity during this time was captured in a section of
the collection booklet dedicated to additional comments, details were limited. Future paramedic
research interventions could look to address exposure to sedentary postures by borrowing
methodology from McKinnon and colleagues (2011) who characterized different in-vehicle
postures of police officers through video-capture. Additionally, other relevant occupational
factors could be measured such as cardiovascular response (Goldstein et al., 1999) and effort
(Montoliu et al., 1995) with heart rate monitors, walked distance per shift with pedometers
(Atkinson et al., 2005), and movement with accelerometers (Estill et al., 2000).

Now that we know the physical demands exposure of paramedics, we need to better understand
the mechanical exposure being placed on their bodies when trying to meet these demands. A
thorough understanding of the most frequently occurring tasks and most physically demanding
aspects of paramedic work can be derived from this research. While previous research has
focussed on trunk postures and estimated spinal loading associated with patient lifting and
transferring tasks (Lavender et al., 2000a; Lavender et al., 2000b), the present research indicates
that paramedics are frequently exposed to physically demanding tasks relating to stretcher and
equipment handling. Future research should look to analyze the demands of these frequently occurring stretcher and equipment handling tasks to quantify the required joint forces, joint moments, and muscular activation.

5.5. Conclusion

Accurate physical demands data is relied on for best informed work-related decisions. For this reason it is essential to understand how well a PDD can be applied in practice after targeted training. Findings from this thesis provide the first objective evidence on the effectiveness of PDD training, indicating that following workshop-style training, novice observers can accurately identify physical demand elements, but fail to quantify physical demand elements against a determined threshold. Building on this understanding, a participatory ergonomics research design was developed which trained paramedics to become observers, and to identify and document the physical demands of paramedic crews during ride-outs. This data can be useful for many applications, for example, in providing a foundation for developing a physical abilities test as a BFOR. Combined, the manuscripts in this thesis have investigated important topics where gaps in literature existed. Several specific conclusions can be drawn from this thesis:

1. PDD training is effective in preparing novices to identify strength and hand activity based physical demand elements whereas mobility and sensory based elements are not as accurately identified.

2. PDD training should provide trainees with thorough practice on the use of measurement tools and procedures to prepare them to accurately quantify physical demand elements.

3. Paramedics identify stretcher loading and unloading, equipment bag carrying, and pushing and pulling a loaded stretcher as the three most physically demanding aspects of their work.
4. Paramedics in high-population services often handle empty stretchers and medication bags more frequently than in low-population services, where policy changes could reduce the exposure to these demands.
5.6. References


Appendix A – OHCOW PDD Workshop Slide Deck
Slide 3

Workshop Objectives

- Introduce the physical demands description tool and its purpose in ergonomics
- Learn how to prepare for, observe, collect, and report physical demands
- Provide you with the necessary tools to perform a Physical Demands Description (PDD)

Slide 4

Today's Agenda

<table>
<thead>
<tr>
<th>TIME</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30</td>
<td>Introduction to the Physical Demands Description</td>
</tr>
<tr>
<td>8:40</td>
<td>PDD Process: Preparing for the PDD</td>
</tr>
<tr>
<td>9:00</td>
<td>PDD Process: Observation &amp; Data Collection</td>
</tr>
<tr>
<td>9:15</td>
<td>Introduction to Physical Demands Elements</td>
</tr>
<tr>
<td>9:25</td>
<td>Classifying tasks: essential and non-essential</td>
</tr>
<tr>
<td>9:30</td>
<td>Activity: Identifying job purpose, tasks, physical demand elements</td>
</tr>
</tbody>
</table>

Slide 5

What is a PDD?

A systematic approach to measure the physical demands of all essential and non-essential tasks of a job

1. Think of a physically demanding job you may have performed
2. Provide a brief summary of the job description
Who Performs PDDs?
Qualified Professionals, including:
• Ergonomic and Health & Safety Professionals
• Canadian Certified Professional Ergonomists (CCPE)
• Registered Kinesiologists (R. Kin)
• Individuals who successfully complete interactive PDD workshops

Where are PDDs performed?
PDDs are performed for nearly every occupation

What is a PDD used for?
Providing information for job description, hiring, and training
Assessing worker's compensation claims
Communicating with health care professionals in job matching and return-to-work
Slide 9

Successful PDD: Job Matching

- Post Offer Employment Test
- Safe & Injury-Free Career
- Physical Demands Description

Slide 10

When MSDs occur

- Repetition, Force, Burnout
- MSD
- Rehabilitation
- Functional Capacity Evaluation
- Job Matching
- Return To Work

Slide 11

Legality of the PDD

Workplace Safety and Insurance Act, 1997, Section 37(3)

"When requested to do so by an injured worker or the employer, a health professional treating the worker shall give the Board, the worker and the employer such information as may be prescribed concerning the worker's functional abilities. The required information must be provided on the prescribed form."

Demands > Capacity
Demands = Capacity
Demands < Capacity
The PDD Process

Preparing for PDD
- Determine where PDD will be done
- Determine who needs to be involved
- Gather all necessary equipment
- Schedule data collection

Observation/ Data Collection
- Verify job purpose and tasks
- Classify essential and non-essential tasks
- Quantify physical demands
- Observation/Data collection

Physical Demands Description
- Descriptive job purposes and tasks
- Identify physical demands
- Classify non-essential and non-repetitive tasks

Finalize template report
- Distribute for sign-off
- File & Back Up

Reporting
Slide 15

Preparing for the PDD

- Determine where the PDD will be done
- Determine who needs to be involved
- Gather all necessary equipment
- Schedule data collection

Slide 16

Determine Where The PDD Will Be Done

- PDD must be conducted at the regular workstation
- Certain jobs may be in greater demand for a PDD
- Documentation required for all jobs
- New processes and equipment since last PDD
- Research the job and any available job descriptions

Slide 17

Determine Who Needs To Be Involved

- Worker
- Supervisor
- Manager
- HR
- Union Representative
- JHSC
Slide 18

Gather All Necessary Equipment

- Pens/Pencils
- PDD Collection Tool
- Measuring Tape
- Force Gauge (Scale)
- Grip Dynamometer
- Stopwatch
- Video Camera
- Digital Camera

Slide 19

Types Of Measurement

- Weight
- Force
- Distance
- Frequency
- Duration

Slide 20

Schedule Data Collection

- Are necessary people available?
- When is the highest/lowest workload?
- Differences in night/day shift?
- Variations in staffing level?
- Consider multiple days of collection
Activity #1

Thinking about your job description ...

• Where would you conduct the PDD? (what locations or branches, what jobs)
• Who would you have to contact to prepare for the PDD?
• Considering scheduling, how many observation sessions would you need and when should those occur?

---

Physical Demands Description

Preparing for the PDD

Observation / Data Collection

Reporting

Observation & Data Collection

Determine job purpose and tasks

Verify job purpose and tasks

Classify essential and non-essential tasks

Quantify physical demands

Clarity essential and non-essential tasks
Determine Job Purpose & Tasks
Converse with the employee, supervisor, HR
Understand the job purpose or objective
Determine all of the job tasks that must be observed and recorded

Verify Purpose & Tasks
Separating the job into job tasks
Tasks must be observed and captured while they are performed
Ask a lot of questions ("what if...?", "how often...?")
Verify (observe) that job tasks are performed as stated in the job description

Job Purpose and Task Flow-Chart
- Task 1
- Task 2
- Task 3
Example: Carpenter

Build a House

Preparing the site

Laying the foundation

Framing

Activity #2

PARTNER UP

Interview your partner to determine the job purpose (from your previous example) and individual job tasks required to achieve that purpose

Observing and Quantifying Physical Demand Elements

All job tasks can be described as "Physical Demand Elements"

Physical Demand Elements are simple and relatable descriptions of human movement
### Slide 42

**Grip - Measurement**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Grip Force</td>
<td></td>
</tr>
<tr>
<td>• Grip Type</td>
<td></td>
</tr>
<tr>
<td>• Direction of turning or manipulation</td>
<td></td>
</tr>
<tr>
<td>• Hand(s) Used</td>
<td></td>
</tr>
<tr>
<td>• Height of hand(s)</td>
<td></td>
</tr>
<tr>
<td>• Frequency</td>
<td></td>
</tr>
<tr>
<td>• Description</td>
<td></td>
</tr>
</tbody>
</table>

### Slide 43

**Pinch**

![Pinch Types Image](http://3.bp.blogspot.com/-5cJ-fO9AVhk/UKeADBnOifI/AAAAAAAADLY/v-C8opcFT1Y/s1600/Three-jaw%2Bchuck%2Bpinch%2B-%2Bgrip%2Btypes.jpg)

### Slide 44

**Pinch - Measurement**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pinch Force</td>
<td></td>
</tr>
<tr>
<td>• Pinch Type</td>
<td></td>
</tr>
<tr>
<td>• Hand(s) Used</td>
<td></td>
</tr>
<tr>
<td>• Height of hand(s)</td>
<td></td>
</tr>
<tr>
<td>• Frequency</td>
<td></td>
</tr>
<tr>
<td>• Description</td>
<td></td>
</tr>
</tbody>
</table>
Slide 45

Write

http://www.confidis.co/images/Writing.jpg

Slide 46

Write - Measurement

Variables
• Type of writing surface
• Type of writing utensil
• Hand(s) Used
• Height of hand(s)
• Frequency
• Duration or amount
• Description

Tools

Slide 47

Fine Finger Movement

http://www.vtlmi.info/occvid/images/49-9043.00-3.jpg

123
Fine Finger Movement - Measurement

Variables
- Number of fingers involved
- Precision involved
- Hands used
- Height of hand(s)
- Frequency
- Description

Tools

<table>
<thead>
<tr>
<th>Variables</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sit

<table>
<thead>
<tr>
<th>Sit - Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Slide 49

Sit - Measurement

<table>
<thead>
<tr>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Slide 50

Sit - Measurement

<table>
<thead>
<tr>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
**Walk - Measurement**

**Variables**
- Walked Distance
- Condition of surface
- Footwear used
- Duration
- Description

**Tools**

**Kneel**

**Kneel - Measurement**

**Variables**
- Type of surface
- One or two knees used
- Frequency
- Duration
- Description

**Tools**
Drive - Measurement

Variables
- Vehicle Type
- Size of steering wheel
- Location/Terrain
- Duration
- Enter & Exit Vehicle Frequency
- Step Height

Foot-Action - Measurement

Variables
- Force
- Height/Location
- Frequency
- Description

Foot-Action

Foot-Action - Measurement

Variables
- Force
- Height/Location
- Frequency
- Description

Foot-Action

Foot-Action - Measurement

Variables
- Force
- Height/Location
- Frequency
- Description
Slide 72

**Taste - Measurement**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Type of food/product</td>
<td></td>
</tr>
<tr>
<td>• Level of recognition/accuracy required</td>
<td></td>
</tr>
<tr>
<td>• Tools used in tasting</td>
<td></td>
</tr>
<tr>
<td>• Description</td>
<td></td>
</tr>
</tbody>
</table>

________________________
________________________
________________________
________________________

Slide 73

**Smell**

________________________
________________________
________________________
________________________

Slide 74

**Smell - Measurement**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Type of odor being smelled</td>
<td></td>
</tr>
<tr>
<td>• Level of recognition/accuracy required</td>
<td></td>
</tr>
<tr>
<td>• Description</td>
<td></td>
</tr>
</tbody>
</table>

________________________
________________________
________________________
________________________
**Slide 78**

**Hear - Measurement**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>- What sounds or words are required to be heard</td>
<td></td>
</tr>
<tr>
<td>- Sound level (dB)</td>
<td></td>
</tr>
<tr>
<td>- Description</td>
<td></td>
</tr>
</tbody>
</table>

**Slide 79**

**Feel/Tactile**

**Slide 80**

**Feel/Tactile - Measurement**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>- What objects are being felt</td>
<td></td>
</tr>
<tr>
<td>- Details of what they are required to detect</td>
<td></td>
</tr>
<tr>
<td>- Description</td>
<td></td>
</tr>
</tbody>
</table>
Slide 81

Vision/Read

http://www.abcnebraska.org/E_newsletter_images/Homepage/Blueprint%20Reading.gif

_________

__________________________

_________

___________________________________

___________________________________

___________________________________

___________________________________

Slide 82

Vision/Read - Measurement

Variables
- What is being viewed/read
- Level of detail required
- Description

Tools

___________________________________

___________________________________

___________________________________

___________________________________

Slide 83

Data Entry

___________________________________

___________________________________

___________________________________

___________________________________

http://newshour.s3.amazonaws.com/photos/2012/10/02/WorkerAtDesk_business_desk.jpg

___________________________________

___________________________________

___________________________________

___________________________________

135
### Data Entry - Measurement

**Variables**
- Duration
- Context (Handwritten, Touchscreen, Keyboard)
- Type of information being entered (words, numbers, sentences, paragraphs)

**Tools**

---

### Work Environment

**Measurement**
- Surface
- Inside/Outside
- Temperature
- Humidity
- Noise
- Vibration
- Congestion
- Lighting
- Required Tools

---

---

---

---

---

---

---

---

---
Slide 87

Example: Carpenter (cont’d)

- Pushing
- Gripping
- Carrying
- Build a House
- Preparing the site
- Laying the foundation
- Framing

Slide 88

Activity #2

- PARTNER UP
  - Interview your partner to determine the physical demand elements of their determined job tasks
    (Normally you would do this via observation and you would quantify them)

Slide 89

Classifying Job Tasks

Essential

Fundamental job duties in which the job is designated for “critical – primary – required – vital”

Non-Essential Tasks

Infrequent job duties, not directly related to job function “peripheral – extra – supplementary”
Classifying Job Tasks

Build a House
- Preparing the site: Essential
- Laying the foundation: Non-Essential
- Framing: Essential

Receptionist
- Essential?
- Non-Essential?

Bus Driver
- Essential?
- Non-Essential?
Slide 93

Cafeteria Worker

Essential?

Non-Essential?


___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

_____________________________

______

___________________________________

___________________________________

___________________________________

___________________________________

Slide 94

Activity #3

• PARTNER UP (Different Pairs)
  – Determine the Essential and Non-Essential tasks of your jobs


___________________________________

___________________________________

___________________________________

___________________________________

___________________________

________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

Slide 95

Activity #4 – Part 1

• Watch the video and determine the job purpose and tasks

Job Purpose

Task 1

Task 2

Task 3


___________________________________

___________________________________

___________________________________

_________________________

__________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________

___________________________________
Case Example #1

Activity #4 – Part 2

- Watch the video again and determine the physical demand elements

Case Example #1
Activity #4 – Part 3

• PARTNER UP (In groups of four)
  – compare your job purpose, tasks and elements
    • What was your job purpose?
    • What job tasks did you identify?
    • How many job tasks did you identify?
    • What physical demands elements did you apply to each job task?

Slide 100

Preparation

Determine where PDD will be done
Determine who needs to be involved
Gather all necessary equipment
Schedule data collection

Observation/Data collection

Finalize template report
Distribute for sign-off

Reporting

File & Back Up

Determine job purpose and tasks
Verify job purpose and tasks
Classify essential and non-essential tasks
Slide 1

KNPE 253: Occupational Biomechanics and Physical Ergonomics

PHYSICAL DEMANDS DESCRIPTION WORKSHOP

Slide 2

Today's Agenda

<table>
<thead>
<tr>
<th>TIME</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00</td>
<td>Brief recap of Monday's Workshop</td>
</tr>
<tr>
<td>10:05</td>
<td>Activity: Identifying job purpose, tasks, physical demand elements</td>
</tr>
<tr>
<td>10:15</td>
<td>Introduction to Measurement</td>
</tr>
<tr>
<td>10:15</td>
<td>Activity: Observing and Measuring Tasks</td>
</tr>
<tr>
<td>10:35</td>
<td>Introduction to the PDD Template</td>
</tr>
<tr>
<td>10:40</td>
<td>Reporting</td>
</tr>
<tr>
<td>10:40</td>
<td>Knowledge Retention Test</td>
</tr>
</tbody>
</table>

Slide 3

Recapping the process

---

142
Slide 4

Determine where PDD will be done
Determine who needs to be involved
Gather all necessary equipment
Schedule data collection
Prepare job purpose and tasks
Classify essential and non-essential tasks
Quantify physical demands
Observation/Data collection
Finalize template report
Distribute for sign-off

Slide 5

Activity #1
• Watch the video and determine the job purpose, job tasks, and physical demand elements

Case Example #2
Activity #1 - Debrief

Job Purpose?
Job Tasks?
Physical Demand Elements?

How do you measure these elements?
How can we measure these physical demands elements?

Types Of Measurement
• Weight
• Force
• Distance
• Frequency
• Duration
Measurement Guidelines

- Measure the frequency and duration of the job task during job observation.
- Measure weights, forces, and distances after job observation.
- Take multiple measurements to determine an average (Minimum of 3 measurements).
- Identify the range in object weights and loads used to determine peak values.
- If there is high variability, also identify range.

Measuring Weight

Force Gauge
- Attach grip/handle
- Turn Force Gauge ON
- Press MODE: Tension
- Tie rope/string to object being weighed
- Press ZERO
- Lift object slowly and record value

Measuring Force

Force Gauge
- Attach appropriate grip/handle
- Turn Force Gauge ON
- Press MODE: Tension or Compression
- Pull = Tension
- Attach appropriate end piece
- Press ZERO
- Have worker Push/Pull object at the normal speed
Measuring Grip/Pinch Force

Dynamometer
- Have worker squeeze the handle to mimic grip used on object
- Make sure the grip force display faces away from them
- Adjust the grip diameter to match that of the object being mimicked

Measuring Distance

Measuring Tape
- Height / Reach / Distance
  - Reach (from a physical barrier)
- Absolute values
  - Platforms
  - Stair height
  - Tables
  - Railings
  - Shelves

Measuring Frequency

Video Camera and/or Stopwatch
- Measure the number of times a task is completed
- Report as a rate per minute
  - If very uncommon (i.e., once or twice per shift, report as both per shift and per minute)
Slide 16

Measuring Duration

Video Camera and/or Stopwatch
• Measure the length of time it takes to complete a task
• Record multiple repetitions to determine an average and peak value

Slide 17

Identifying Grip Type

Wells & Grieg, 2001
Power Grip
Palm Grip
Tip Grip
Hook Grip

Slide 18

Identifying Pinch Type

How To Take Photographs

Photographs add value to the final report
They should clearly illustrate physical demands
Position yourself at a 90° angle to the worker
Minimize unnecessary backgrounds
Maintain worker anonymity

Photograph Examples


Introducing the PDD Template

Physical Demand Elements are measured differently
Mobility, Sensory, Dexterity, and Strength-related tasks require different methods of measurement
### Slide 22

<table>
<thead>
<tr>
<th>Physical Demand Elements</th>
<th>Measurement Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lift/Lower</td>
<td>Weight</td>
</tr>
<tr>
<td></td>
<td>Lift Height</td>
</tr>
<tr>
<td></td>
<td>Hand(s) Used</td>
</tr>
<tr>
<td></td>
<td>Horizontal Reach</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Carry</td>
<td>Weight</td>
</tr>
<tr>
<td></td>
<td>Carry Height</td>
</tr>
<tr>
<td></td>
<td>Carry Distance</td>
</tr>
<tr>
<td></td>
<td>Hand(s) Used</td>
</tr>
<tr>
<td></td>
<td>Grip</td>
</tr>
<tr>
<td></td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Push</td>
<td>Force</td>
</tr>
<tr>
<td></td>
<td>Push Height</td>
</tr>
<tr>
<td></td>
<td>Push Distance</td>
</tr>
<tr>
<td></td>
<td>Hand(s) Used</td>
</tr>
<tr>
<td></td>
<td>Grip Type</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Pull</td>
<td>Force</td>
</tr>
<tr>
<td></td>
<td>Pull Height</td>
</tr>
<tr>
<td></td>
<td>Pull Distance</td>
</tr>
<tr>
<td></td>
<td>Hand(s) Used</td>
</tr>
<tr>
<td></td>
<td>Grip Type</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Reach</td>
<td>Hand Height</td>
</tr>
<tr>
<td></td>
<td>Arm(s) Used</td>
</tr>
<tr>
<td></td>
<td>Reach Distance</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Grip</td>
<td>Hand Height</td>
</tr>
<tr>
<td></td>
<td>Grip Force</td>
</tr>
<tr>
<td></td>
<td>Grip Type</td>
</tr>
<tr>
<td></td>
<td>Hand(s) Used</td>
</tr>
<tr>
<td></td>
<td>Direction of Turning</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Pinch</td>
<td>Hand Height</td>
</tr>
<tr>
<td></td>
<td>Pinch Force</td>
</tr>
<tr>
<td></td>
<td>Pinch Type</td>
</tr>
<tr>
<td></td>
<td>Hand(s) Used</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Write</td>
<td>Hand Height</td>
</tr>
<tr>
<td></td>
<td>Writing Surface</td>
</tr>
<tr>
<td></td>
<td>Writing Utensil</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Hand(s) Used</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Fine Finger Movement</td>
<td>Hand Height</td>
</tr>
<tr>
<td></td>
<td>Number of Fingers</td>
</tr>
<tr>
<td></td>
<td>Precision Required</td>
</tr>
<tr>
<td></td>
<td>Hand(s) Used</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Sit</td>
<td>Surface Condition</td>
</tr>
<tr>
<td></td>
<td>Seat Height</td>
</tr>
<tr>
<td></td>
<td>Seat Dimensions</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Stand</td>
<td>Surface Condition</td>
</tr>
<tr>
<td></td>
<td>Footwear Used</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Walk</td>
<td>Surface Condition</td>
</tr>
<tr>
<td></td>
<td>Footwear Used</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Walk Distance</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Kneel</td>
<td>Surface Condition</td>
</tr>
<tr>
<td></td>
<td>Knee(s) Used</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Crouch/Squat</td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Balance</td>
<td>Surface Condition</td>
</tr>
<tr>
<td></td>
<td>Leg(s) Used</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Crawl</td>
<td>Surface Condition</td>
</tr>
<tr>
<td></td>
<td>Crawl Distance</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Climb</td>
<td>Surface Condition</td>
</tr>
<tr>
<td></td>
<td>Climb Distance</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Taste</td>
<td>Type of product</td>
</tr>
<tr>
<td></td>
<td>Precision Required</td>
</tr>
<tr>
<td></td>
<td>Tool(s) Used</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Smell</td>
<td>Type of Odour</td>
</tr>
<tr>
<td></td>
<td>Precision Required</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Speech</td>
<td>Purpose of Speech</td>
</tr>
<tr>
<td></td>
<td>Level of Detail</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Hear</td>
<td>Type of Sound</td>
</tr>
<tr>
<td></td>
<td>Sound Level</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Feel/Tactile</td>
<td>Type of Object</td>
</tr>
<tr>
<td></td>
<td>Precision Required</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Vision/Read</td>
<td>Type of Object</td>
</tr>
<tr>
<td></td>
<td>Level of Detail</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Data Entry</td>
<td>Type of Technology</td>
</tr>
<tr>
<td></td>
<td>Amount of Data</td>
</tr>
<tr>
<td></td>
<td>Hand(s) Used</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Driving</td>
<td>Hand Height</td>
</tr>
<tr>
<td></td>
<td>Type of Vehicle</td>
</tr>
<tr>
<td></td>
<td>Steering Mechanism</td>
</tr>
<tr>
<td></td>
<td>Driving Surface</td>
</tr>
<tr>
<td></td>
<td>Surroundings</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Foot - Action</td>
<td>Foot Force</td>
</tr>
<tr>
<td></td>
<td>Type of Object</td>
</tr>
<tr>
<td></td>
<td>Foot Height</td>
</tr>
<tr>
<td></td>
<td>Foot Required</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
<tr>
<td>Odd Object Handling</td>
<td>Weight</td>
</tr>
<tr>
<td></td>
<td>Object Type</td>
</tr>
<tr>
<td></td>
<td>Handling Height</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Comment</td>
</tr>
</tbody>
</table>

### Slide 23

**Connecting the demands with the PDD Template**

- Build a House
- Preparing the site
- Laying the foundation
- Framing
- Pushing
- Handling
- Carrying

### Slide 24

**Connecting the demands with the PDD Template**

- Build a House
- Preparing the site
- Pushing
Slide 28

Example using the PDD Template

<table>
<thead>
<tr>
<th>Task</th>
<th>Push Force [N]</th>
<th>Push Height [cm]</th>
<th>Distance [m]</th>
<th>Hand(s) Used</th>
<th>Grip Type</th>
<th>Frequency [times/minute]</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1</td>
<td>Avg: 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 2</td>
<td>Avg: 50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 3</td>
<td>Avg: 55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Slide 29

Activity #2

- PARTNER UP (Groups of 5)
  - Activity 1: Repetitive Lifting (quantify lifting)
  - Activity 2: Lift-Carry-Place (quantify all elements)
  - Activity 3: Light Assembly (quantify all elements)
- Take a quality picture of each task

Slide 30

Activity #2 Debrief

What Physical Demand Elements did you identify?

What measurements did you record?

Difficulties?
Classifying Job Tasks

Essential
Fundamental job duties in which the job is designated for
“critical – primary – required – vital”

Non-Essential Tasks
Infrequent job duties, not directly related to job function
“peripheral – extra – supplementary”

Classifying Job Tasks
Build a House
Preparing the site
Laying the foundation
Framing
Essential
Non-Essential
Essential

Receptionist
Essential?
Non-Essential?
Slide 34

Cafeteria Worker

Essential?
Non-Essential?


___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________

Slide 35

Activity #3

• PARTNER UP (Different Pairs)
  – Determine the Essential and Non-Essential tasks of your jobs (from Monday)


___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________

Slide 36

Physical Demands Description

Preparing for the PDD
Observation / Data Collection
Reporting


___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________

153
Slide 37

Reporting

Finalize template report
Distribute for sign-off
File & Back-Up

Slide 38

Finalize Template Report

1. Job Overview and Summary (job purpose, work/break schedule, PPE/education requirements, etc.)
2. List and define Essential and Non-Essential Tasks
3. Combine the Physical Demand Elements across all tasks and summarize them in a single version of the template with all appropriate measurements and photographs (worker permitting)

Slide 39

Finalize Template Report: Summary

Job Title: Paramedic
Job Description: Has the interchangeable role of driver and attendant, who provides effective assessment, treatment and transportation of patients to medical and/or any other facility. Advanced Care Paramedics perform medical duties in accordance with basic life support (BLS), advanced life support policies (ALS), procedures and guidelines, standing orders.
Job Responsibilities: Treat and transport patients in ambulance, vehicle maintenance and driving, documentation.
Work Schedule: 12 hour and 8 hour shifts. No scheduled breaks, paramedics take breaks when available and may miss meals. Full time: 40-42 hours per week. Part time: 24 hours per week.
Finalize Template Report: Essential & Non-Essential Tasks

Essential Tasks

1. Physical/Strength: Must be able to lift and carry patients on a stretcher. Each call requires at least 6 lifts of stretcher & stretcher with patient (Up to 95 cm vertically). Must be able to push/pull patients on stretcher in various environments (Forces up to 40+ N per person).

2. Mobility: Must be able to sit, stand, walk, bend, squat, kneel, as required to respond to calls – varies daily.

3. Dexterity: Must have fine motor skills in hands to set up treatments, IVs, drugs, etc.

4. Mental: Must have college level paramedic certification. Must be able to make quick, accurate decisions.

5. Sensory/Perceptual: Must communicate and write in English. Must see colour to diagnose and treat patients. Must feel for skin temperature, assess injuries, perform CPR, and other tasks at the patient’s service.

Non-essential

1. Cleaning: Sweeping, vacuuming, doing dishes, emptying trash and other related duties at the paramedic service.

2. Washing: Using the washer and dryer to clean PPE, towels, jackets, and other laundry at the paramedic service.

---

Finalize Template Report: Summarizing the Physical Demand Elements

Lift/Lower

<table>
<thead>
<tr>
<th>Task</th>
<th>Equipment Handling</th>
<th>Weight [kg]</th>
<th>Height [cm]</th>
<th>Hand(s) Used</th>
<th>Horizontal Reach</th>
<th>Frequency [ / min]</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equipment Handling</td>
<td>5</td>
<td>15</td>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Stretcher Lift (Empty)</td>
<td>45</td>
<td>50</td>
<td>Both</td>
<td></td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Stretcher Lift (Loaded)</td>
<td>115</td>
<td>150</td>
<td>Both</td>
<td></td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

---

Finalize Template Report: Summarizing the Physical Demand Elements

Lift/Lower

<table>
<thead>
<tr>
<th>Task</th>
<th>Total Weight [kg]</th>
<th>Height [cm]</th>
<th>Hand(s) Used</th>
<th>Horizontal Reach</th>
<th>Frequency [ / min]</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>55</td>
<td>75</td>
<td>One or Both</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>180</td>
<td>118</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Review & Sign-off
Have worker and supervisors sign-off on your PDD document to verify its accuracy and completeness.

File & Back-Up
Store your PDD collection in a location that can be accessed by all authorized individuals.

Keep multiple copies of both hard and electronic copies.

Locked PDF files are preferable to prevent unauthorized modifications.

Timeline for Review & Updates
Employers should review their PDD regularly to be sure it accurately portrays the job demands.

Necessary to review and compare the worker’s physical capacities with the job demands in the case of modified work duties./return-to-work

An updated PDD is may be necessary
• Whenever new processes and equipment are introduced
• Should aim to update annually.
Slide 46

- Review & Update
  - Determine where PDD will be done
  - Determine who needs to be involved
  - Gather all necessary equipment
  - Schedule data collection
  - Determine job purpose and tasks
  - Verify job purpose and tasks
  - Classify essential and non-essential tasks
  - Quantify physical demands

- Finalize template report
- Distribute for sign-off

Slide 47

- Knowledge Retention Test

Slide 48

- Physical Demand Elements
  - Measurement Variables
    - Lift/Lower
    - Carry
    - Push
    - Pull
    - Reach
    - Grip
    - Pinch
    - Write
    - Fine Finger Movement
    - Sit
    - Stand
    - Walk
    - Kneel
    - Crouch/Squat
    - Balance
    - Crawl
    - Climb
    - Taste
    - Smell
    - Speech
    - Hear
    - Feel/Tactile
    - Vision/Read
    - Data Entry
    - Driving
    - Foot-Action
    - Odd Object Handling

<table>
<thead>
<tr>
<th>Element</th>
<th>Measurement Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lift/Lower Weight</td>
<td>1: 4  2: 26  3: 50  4: 68  5: 90  6: 112</td>
</tr>
<tr>
<td>Lift Height</td>
<td>52 cm</td>
</tr>
<tr>
<td>Hand(s) Used</td>
<td>Both</td>
</tr>
<tr>
<td>Suitable Reach</td>
<td>52 cm</td>
</tr>
<tr>
<td>Frequency</td>
<td>Push</td>
</tr>
<tr>
<td>Push Force</td>
<td>90 steps</td>
</tr>
<tr>
<td>Hand Height</td>
<td>82 cm</td>
</tr>
<tr>
<td>Grip Type</td>
<td>Both</td>
</tr>
<tr>
<td>Direction Turn</td>
<td>Crouch/Squat</td>
</tr>
<tr>
<td>Duration</td>
<td>12</td>
</tr>
<tr>
<td>Pull Force</td>
<td>45 steps</td>
</tr>
<tr>
<td>Pull Height</td>
<td>82 cm</td>
</tr>
<tr>
<td>Footwear</td>
<td>Boat shoes</td>
</tr>
<tr>
<td>Surface Condition</td>
<td>Ceramic/tile</td>
</tr>
<tr>
<td>Duration</td>
<td>135 steps</td>
</tr>
<tr>
<td>Walk Distance</td>
<td>135 steps</td>
</tr>
</tbody>
</table>
### Appendix B – OHCOW PDD Template

**APPENDIX: PDD TEMPLATE**

**PHYSICAL DEMANDS DESCRIPTION | Job Title:**

- **Date:**
- **Department:** Department Name
- **Work Hours:** e.g., 8:00AM - 6:00PM
- **Schedule:** e.g., Monday - Friday
- **Shift:** e.g., 'Nights', 'A'
- **Completed by:** Name of Observer
- **Verified by:** Worker Representative
  - Management Representative
- **PPE:** Personal Protective Equipment used

**Description of the Job:** Describe the overall purpose of the job here

**Summary of Essential Tasks**

<table>
<thead>
<tr>
<th>TASK NAME</th>
<th>FREQUENCY</th>
<th>TOTAL DURATION</th>
<th>% OF WORK TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Summary of Non-Essential Tasks**

<table>
<thead>
<tr>
<th>TASK NAME</th>
<th>FREQUENCY</th>
<th>TOTAL DURATION</th>
<th>% OF WORK TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Environmental Factors (Check all that apply):**

- [ ] Indoor
- [ ] Rugged Terrain
- [ ] Cold
- [ ] Slippery
- [ ] Vibration
- [ ] Gas/Fumes
- [ ] Outdoor
- [ ] Weather
- [ ] Dry
- [ ] Dark
- [ ] Traffic
- [ ] Magnetic Fields
- [ ] Cold Surface
- [ ] Hot
- [ ] Wet
- [ ] Bright
- [ ] Biological Agents
- [ ] Congested Area
- [ ] Noise
- [ ] Other
- [ ] Chemicals

**Summary of Tools & Equipment**

<table>
<thead>
<tr>
<th>TOOL/EQUIPMENT</th>
<th>MAKE</th>
<th>MODEL</th>
<th>WEIGHT</th>
<th>DIMENSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Photographs of Tools & Equipment**

To download a digital version of this PDD Template, visit: www.ohcow.on.ca/resources
### Physical Demand Task Details

<table>
<thead>
<tr>
<th>Task Elements</th>
<th>Measure 1</th>
<th>Measure 2</th>
<th>Measure 3</th>
<th>Measure 4</th>
<th>Measure 5</th>
<th>Measure 6</th>
<th>Measure 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Element 2</td>
<td>Measure 2</td>
<td>Measure 2</td>
<td>Measure 3</td>
<td>Measure 4</td>
<td>Measure 5</td>
<td>Measure 6</td>
<td>Measure 7</td>
</tr>
<tr>
<td>Element 3</td>
<td>Measure 2</td>
<td>Measure 2</td>
<td>Measure 3</td>
<td>Measure 4</td>
<td>Measure 5</td>
<td>Measure 6</td>
<td>Measure 7</td>
</tr>
<tr>
<td>Element n</td>
<td>Measure 2</td>
<td>Measure 2</td>
<td>Measure 3</td>
<td>Measure 4</td>
<td>Measure 5</td>
<td>Measure 6</td>
<td>Measure 7</td>
</tr>
</tbody>
</table>

1. Task Name

INSERT PHOTO OF TASK

Description of the task and environmental factors (what, where, how, etc.)

<table>
<thead>
<tr>
<th>Task Elements</th>
<th>Measure 1</th>
<th>Measure 2</th>
<th>Measure 3</th>
<th>Measure 4</th>
<th>Measure 5</th>
<th>Measure 6</th>
<th>Measure 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Element 2</td>
<td>Measure 2</td>
<td>Measure 2</td>
<td>Measure 3</td>
<td>Measure 4</td>
<td>Measure 5</td>
<td>Measure 6</td>
<td>Measure 7</td>
</tr>
<tr>
<td>Element 3</td>
<td>Measure 2</td>
<td>Measure 2</td>
<td>Measure 3</td>
<td>Measure 4</td>
<td>Measure 5</td>
<td>Measure 6</td>
<td>Measure 7</td>
</tr>
<tr>
<td>Element n</td>
<td>Measure 2</td>
<td>Measure 2</td>
<td>Measure 3</td>
<td>Measure 4</td>
<td>Measure 5</td>
<td>Measure 6</td>
<td>Measure 7</td>
</tr>
<tr>
<td>Physical Demand Element</td>
<td>Measures to Document in the PDD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lift/Lower</td>
<td>Frequency, Weight, Start Height, End Height, Hand(s) Used, Reach, Grip Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carry</td>
<td>Frequency, Weight, Height, Distance, Hand(s) Used, Reach, Grip Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Push</td>
<td>Frequency, Average Force, Max Force, Height, Distance, Hand(s) Used, Grip Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pull</td>
<td>Frequency, Average Force, Max Force, Height, Distance, Hand(s) Used, Grip Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach</td>
<td>Frequency, Height, Distance, Hand(s) Used, Grip Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grip</td>
<td>Frequency, Force, Height, Direction, Hand(s) Used, Reach, Grip Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinch</td>
<td>Frequency, Force, Height, Pinch Type, Hand(s) Used, Reach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write</td>
<td>Frequency, Duration, Height, Surface, Tool Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine Finger Movement</td>
<td>Frequency, Duration, Height, Finger(s) Used, Hand(s) Used, Precision Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sit</td>
<td>Duration, Seat Height, Dimensions, Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stand</td>
<td>Duration, Surface, Footwear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>Duration, Distance, Surface, Footwear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kneel</td>
<td>Duration, Knee(s) Used, Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crosswalk/Squat</td>
<td>Frequency, Duration, Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance</td>
<td>Duration, Leg(s) Used, Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crawl</td>
<td>Frequency, Duration, Distance, Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climb</td>
<td>Frequency, Duration, Distance, Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taste</td>
<td>Frequency, Food(s), Precision Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smell</td>
<td>Frequency, Odour Type(s), Precision Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speech</td>
<td>Frequency, Information, Level of Detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hear</td>
<td>Frequency, Duration, Sound(s), Sound Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feel/Tactile</td>
<td>Frequency, Duration, Material(s), Precision Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vision/Read</td>
<td>Frequency, Information, Level of Detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Entry</td>
<td>Frequency, Information, Technology, Hand(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving</td>
<td>Duration, Hand Height, Vehicle, Surface, Surroundings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot Action</td>
<td>Frequency, Force, Height, Object, Foot/Feet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handling of Odd Objects</td>
<td>Frequency, Duration, Weight, Height, Object</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To download a digital version of this PDD Template, visit: [www.ohoow.on.ca/resources](http://www.ohoow.on.ca/resources)
Appendix C – Paramedic PDD Training Slide Deck

Slide 1

Physical Demands Analysis Workshop

Slide 2

The Research Team

- Brendan Coffey
  - MSc Candidate
  - Queen’s University

- Steve Fischer, PhD, RKn
  - Principal Investigator
  - Queen’s University

- Renée S. MacPhee, PhD
  - Co-Investigator
  - Wilfrid Laurier University

- Doug Socha (DRDC CSS)
  - Research Program Manager
  - Defence Research Canada
Slide 3

Research & Funding Partners

- Defence Research & Development Canada
- Paramedic Association of Canada
- Paramedic Chiefs of Canada
- Centre of Research Expertise for the Prevention of Musculoskeletal Disorders

Slide 4

Today's Agenda

<table>
<thead>
<tr>
<th>TIME</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td>Introduction &amp; Pre-Workshop Evaluation</td>
</tr>
<tr>
<td>9:15</td>
<td>PMT Information</td>
</tr>
<tr>
<td>9:30</td>
<td>Preparing to Conduct the PSA</td>
</tr>
<tr>
<td>10:00</td>
<td>Break</td>
</tr>
<tr>
<td>10:15</td>
<td>Discussing &amp; Collecting Demands</td>
</tr>
<tr>
<td>11:15</td>
<td>Introduction to PSA Template</td>
</tr>
<tr>
<td>11:30</td>
<td>Lunch</td>
</tr>
<tr>
<td>12:00</td>
<td>Mock PSA Templates &amp; Practice</td>
</tr>
<tr>
<td>12:45</td>
<td>Post-Workshop Evaluation</td>
</tr>
</tbody>
</table>

Slide 5

Canadian Paramedic Research
Evidence to inform practice

“Evidence based medicine is the "...conscientious, explicit, and judicious use of current best evidence in making decisions..."”

Sackett et al, 1996
Slide 9

**What is a PDA?**

- Systematic approach to capture job demands
- A method for describing the requirements of job activities and tasks

---

Slide 10

**Who performs PDAs?**

---

Slide 11

**Where is a PDA performed?**

- PDAs are performed for nearly every occupation
Why do we need PDAs?
Providing benchmarks to:
1. Prioritize interventions
2. Understand required physical capabilities
3. Progress injury treatment and improve return-to-work processes

Who uses PDAs?
Employers & Human Resources  Medical Professionals  Worker's Compensation Boards

What does a PDA look like
Slide 15

___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
__________________________________

___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________

Slide 16

Paramedic PDA Involvement

___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________
___________________________________

Slide 17

Paramedic Engagement in the PDA process

Research objectives:

- Identify the physical demands of day-to-day work of a paramedic
- Accurately gather detailed information
- Engage paramedics in the data collection process
Paramedic Engagement in the PDA process

Workshop objectives:
- Learn how to observe the physical demands throughout a call
- Learn how to collect the necessary physical demands information
- Provide you with the necessary tools to complete the PDA process

The PDA Process

Physical Demands Analysis

Phase 1: Preparing for the PDA
Phase 2: Observation & Data Collection
Phase 3: Reporting
Preparing to Conduct a PDA

**Determine where**
Thunder Bay

**Determine when**
Two ride-outs (to be scheduled), 1 day, 1 night

**Determine who is involved**

---

Preparation: Where and When?

Plan to accommodate varying shift schedules

Aim to capture every detail

---

Preparation: Who?

Determining who is involved in the PDA process

PCC / Paramedics / Research Team
**Slide 24**

**Preparation: Data Collection**

Remind paramedics that you are observing and documenting the tasks not how each individual performed each task.

Notify the paramedics that your role is solely as an observer for data collection.

Aim for best vantage points.

---

**Slide 25**

**Preparation: Equipment**

- Pens/Pencils
- PDA Collection Tool
- Additional Notebook
- Watch
- Measuring Tape
- Stopwatch

---

**Slide 26**

**Physical Demands Analysis**

- **Phase 1:** Preparing for the PDA
- **Phase 2:** Observation & Data Collection
- **Phase 3:** Reporting

---
Observation & Data Collection

Determine job purpose and tasks
Classify essential & non-essential tasks
Verify job purpose and tasks
Quantify and report physical demands

Determining job purpose and tasks

How would you describe your job?

Determining job purpose and tasks

Paramedic Job Description #1

“Assess extent of injuries or illness of trauma victims to determine emergency medical treatment, Administer pre-hospital emergency care, Administer medications and provide advanced emergency treatments to patients, Document and record nature of injuries and treatment provided, maintain ambulances and emergency care equipment and supplies.”
Determine job purpose and tasks

Paramedic Job Description #2

“As a health care provider, you will be a patient advocate who effectively communicates and interacts with community partners and allied professionals to ensure safe and proficient patient care and transportation. To fulfill your responsibilities you will safely operate emergency vehicles, respond to medical and traumatic emergencies and inter-facility transport requests while adhering to professional standards, medical control protocols, standard operating procedures, policies and directives. This job requires the ability to lift and move patients and equipment.”

Classify job tasks

Essential
Fundamental job duties in which the job is designated for “critical – primary – required – vital”

Non-Essential Tasks
Infrequent job duties, not directly related to job function “peripheral – extra – supplementary”

Verify job activities, tasks and equipment used

“Lifting the stretcher from the ambulance”
“Performing CPR”
“Carrying the airway bag”
**Slide 33**

**Using physical demands lingo**

Look to identify and describe activities by using these actions:
- Walking
- Carrying
- Lifting / Lowering
- Pushing / Pulling
- Twisting
- Reaching
- Precise movements

---

**Slide 34**

**Quantifying physical demands**

Include these types of quantitative measurement:
- Frequency
- Duration
- Height (Absolute)

---

**Slide 35**

**Recap**

- Paramedic related tasks
- Physical demands keywords
- Measurement
Document the physical demands by considering the following:

• What activities were performed?
• What equipment was used?
• How many times did those activities occur?
• How long did those activities occur for?
• Can the height or distance of the activity be measured?
Document the physical demands by considering the following:

• What activities were performed?
• What equipment was used?
• How many times did those activities occur?
• How long did those activities occur for?
• Can the height or distance of the activity be measured?
Document the physical demands by considering the following:

• What activities were performed?
• What equipment was used?
• How many times did those activities occur?
• How long did those activities occur for?
• Can the height or distance of the activity be measured?
Slide 45

Paramedic PDA Template

Data Collection Tool

----------------------------------
----------------------------------
----------------------------------
----------------------------------

Slide 46

Key Section in the template

1. Paramedic Demographics
2. Equipment Information
3. Start of Shift Vehicle Check (Activities/Task List)
4. Call Information
5. Clinical Information
6. Arrival at Scene (Activities/Task List)
7. Patient Assessment and Care (Activities/Task List)
8. Patient Transport to Ambulance (Activities/Task List)
9. Patient Transport to Hospital (Activities/Task List)
10. Post Call (Activities/Task List)
11. Distance Measures
12. Perceived Call Difficulty

Slide 47

PDA Template

Section 1: Paramedic Demographics

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Handedness</th>
<th>Paramedic Skill Level</th>
<th>Total years of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>F</td>
<td></td>
<td>PCP</td>
<td>7</td>
</tr>
<tr>
<td>41</td>
<td>M</td>
<td></td>
<td>PCP</td>
<td>16</td>
</tr>
</tbody>
</table>

Paramedic #1 (Attending)
Paramedic #2
Slide 48

**PDA Template**

**Section 2: Equipment Information**

<table>
<thead>
<tr>
<th>Make &amp; Model of Vehicle:</th>
<th>Vehicle Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM</td>
<td>4112</td>
</tr>
</tbody>
</table>

**Distance from ground to cab (cm):** 48

**Distance from ground to rear compartment (cm):** 72

**Type of lift device used (e.g., manual stretcher, power cot, scoop, KED, backboard):** backboard

**Cardiac Monitor (type):** Life Pack 15

---

Slide 49

**Section 3: Start of Shift Vehicle Check – Activities / Tasks List**

---

Slide 50

**Section 4: Call Information**

<table>
<thead>
<tr>
<th>Date of call: 13/11/2013</th>
<th>Crew Type: PCP / ACP / CCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call Received: 18:03</td>
<td>Crew Notified: 18:05</td>
</tr>
<tr>
<td>Crew Mobile: 18:10</td>
<td>Arrive Scene: 18:18</td>
</tr>
<tr>
<td>Arrive Patient: 18:21</td>
<td>Depart Scene: 18:45</td>
</tr>
<tr>
<td>Arrive Destination: 19:00</td>
<td>Transfer of Care: 19:06</td>
</tr>
</tbody>
</table>

**Dispatch Priority Code:**

**Return Priority Code:**

**Start km:** 108,718

**End km:** 108,730

**Environmental conditions (please describe):**

- High winds
- Cold (~2°C)
- Dusk
- Rain
Slide 51

Section 5: Clinical Information

- Patient Gender: M
- Patient Age: 66
- Patient Weight (kg): 104
- Patient Height (cm): 180
- Dispatch Problem Code: 99
- Final Primary Problem Code: 72
- CTAS Level: 5

Slide 52

Section 6: Arrival at Scene

- i.e. "exited cab – entered rear of the ambulance"
- i.e. "lifted stretcher out of the ambulance and loaded bags onto stretcher for transport"

Slide 53

Section 7: Patient Assessment and Care

- i.e. "lifted bags from stretcher and placed on floor"
- i.e. "lowered stretcher to floor height"
Section 8: Patient Transport to Ambulance
- i.e. “lowered patient down three flights of stairs using the stair chair”
- i.e. “pushed stretcher loaded with patient and bags across 20 feet of grass”

Section 9: Patient Transport to Hospital
- i.e. “Drove ambulance to hospital”
- i.e. “Pressed foot pump 6 times to elevate the hospital bed”

Section 10: Post Call
- i.e. “cleaned and disinfected stretcher for 3 minutes”
- i.e. “with laptop placed on lap, performed data entry tasks for 5 minutes”
PDA Template

Section 11: Distance Measures

| Distance from ambulance to scene | 100 meters |

Section 12: Perceived Call Difficulty

<table>
<thead>
<tr>
<th>Task</th>
<th>Rating Scale (0-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most physically demanding task on call</td>
<td>7</td>
</tr>
</tbody>
</table>

Bed to stretcher transfer (7)

Level of difficulty of call:

- Clinically – 4
- Physically – 6
- Emotionally – 1

Section 11: Distance Measures
Section 12: Perceived Call Difficulty

Physical Demands Analysis

Phase 1: Preparing for the PDA
Phase 2: Observation & Data Collection
Phase 3: Reporting

Distributing for sign-off
Finalizing the written PDA report
Questions?

Contact Information

Brendan  1bc20@queensu.ca  (613) 533-6000 ext.79019
Renée  rmacphee@wlu.ca  (519) 884-0710 ext. 2754
Steve  steve.fischer@queensu.ca  (613) 533-6000 ext. 75210
Appendix D – Paramedic PDD Data Collection Template

PARAMEDICS PHYSICAL DEMANDS ANALYSIS RESEARCH PROJECT

Physical Demands Data Collection Form

A fillable form to gather physical demands data

Last Revised:
11/05/2013

This document has been prepared as a tool to help paramedics document and quantify key details about the physical demands required in their work. It is not intended for use by paramedics that have not attended the physical demands analysis workshop.
**Physical Demands Data Collection Form**

**SECTION 1: Paramedic Demographics**

**Paramedic #1 (Attending)**

<table>
<thead>
<tr>
<th>Age:</th>
<th>Gender:</th>
<th>Handedness (circle one): Left</th>
<th>Right</th>
<th>Equal</th>
</tr>
</thead>
</table>

Paramedic Skill Level (circle one): PCP  
Other (please specify):  
ACP  
CCP  

Total years of Service (regardless of skill level):  

**Paramedic #2**

<table>
<thead>
<tr>
<th>Age:</th>
<th>Gender:</th>
<th>Handedness (circle one): Left</th>
<th>Right</th>
<th>Equal</th>
</tr>
</thead>
</table>

Paramedic Skill Level (circle one): PCP  
Other (please specify):  
ACP  
CCP  

Total years of Service (regardless of skill level):  

**SECTION 2: Equipment Information**

<table>
<thead>
<tr>
<th>Make, Model and Vehicle #:</th>
<th>Distance from ground to cab (cm):</th>
<th>Distance from ground to rear compartment (cm):</th>
</tr>
</thead>
</table>

Type of lift device used (e.g., manual stretcher, power cot, scoop, KED, backboard, lift sheet):  

Cardiac Monitor (type):
**SECTION 3: Start of Shift Vehicle Check – Activities / Tasks List**

- *i.e. “lift airway bag to stretcher, inspect airway bag, lift back to standard location”*

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
## Sections 4 - 12 to be completed for each call

### SECTION 4: Call Information

<table>
<thead>
<tr>
<th>Date of call:</th>
<th>Crew Type: PCP / ACP / CCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call Received:</td>
<td>Crew Notified:</td>
</tr>
<tr>
<td></td>
<td>Crew Mobile:</td>
</tr>
<tr>
<td>Arrive Patient:</td>
<td>Depart Scene:</td>
</tr>
<tr>
<td></td>
<td>Arrive Destination:</td>
</tr>
<tr>
<td></td>
<td>Transfer of Care:</td>
</tr>
<tr>
<td>Dispatch Priority Code:</td>
<td>Return Priority Code:</td>
</tr>
<tr>
<td>Start km:</td>
<td>End km:</td>
</tr>
<tr>
<td>Environmental conditions (please describe):</td>
<td></td>
</tr>
</tbody>
</table>

### SECTION 5: Clinical Information

<table>
<thead>
<tr>
<th>Patient Gender:</th>
<th>Patient Age:</th>
<th>Patient Weight (kg):</th>
<th>Patient Height (cm):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispatch Problem Code:</td>
<td>Final Primary Problem Code:</td>
<td>CTAS Level:</td>
<td></td>
</tr>
</tbody>
</table>
### SECTION 6: Arrival at Scene – Activities / Tasks List

- *i.e. “exited cab – entered rear of the ambulance”*

- *i.e. “lifted stretcher out of the ambulance, loaded bags onto stretcher for transport”*

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

-
### SECTION 7: Patient Assessment and Care – Activities / Tasks List

- i.e. “lifted bags from stretcher and placed on floor”

- i.e. “lowered stretcher to floor height”
## SECTION 8: Patient Transport to Ambulance – Activities / Tasks List

- *i.e. “lowered patient down three flights of stairs using the stair chair”*

- *i.e. “pushed stretcher loaded with patient and bags across 20 feet of grass”*

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

- 

-
### SECTION 9: Patient Transport to Hospital / Arrival at Hospital– Activities / Tasks List

- i.e. “Drove ambulance to hospital approximately 15 minutes”

- i.e. “Pressed foot pump 6 times to elevate the hospital bed”
SECTION 10: Post Call – Activities / Tasks List

- i.e. “cleaned and disinfected stretcher for 3 minutes”

- i.e. “with laptop placed on lap, performed data entry tasks for 5 minutes”

<table>
<thead>
<tr>
<th></th>
<th>From ambulance to scene of patient (without patient on stretcher)</th>
<th>From scene of patient return to ambulance (with patient on stretcher)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (m)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SECTION 12: Perceived Call Difficulty**

<table>
<thead>
<tr>
<th>Task</th>
<th>Rating Scale (0-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most physically demanding task on call</td>
<td></td>
</tr>
<tr>
<td>Level of difficulty of call:</td>
<td></td>
</tr>
<tr>
<td>• clinically</td>
<td></td>
</tr>
<tr>
<td>• physically</td>
<td></td>
</tr>
<tr>
<td>• emotionally</td>
<td></td>
</tr>
</tbody>
</table>

**ADDITIONAL NOTES AND COMMENTS:**

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
Appendix E – Ethics Approval and Consent Forms

QUEEN’S UNIVERSITY HEALTH SCIENCES & AFFILIATED TEACHING HOSPITALS
RESEARCH ETHICS BOARD-DELEGATED REVIEW

May 03, 2013

Mr. Brendan Coffey
School of Kinesiology & Health Studies
Queen’s University

Dear Mr. Coffey

Study Title: PHE-132-13 A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work

File # 6007982

Co-Investigators: Dr. S. Fischer and Dr. R. MacPhee

I am writing to acknowledge receipt of your recent ethics submission. We have examined the protocol, revised letter of information and revised consent form for your project (as stated above) and consider it to be ethically acceptable. This approval is valid for one year from the date of the Chair’s signature below. This approval will be reported to the Research Ethics Board. Please attend carefully to the following listing of ethics requirements you must fulfill over the course of your study:

Reporting of Amendments: If there are any changes to your study (e.g. consent, protocol, study procedures, etc.), you must submit an amendment to the Research Ethics Board for approval. Please use event form: HSREB Multi-Use Amendment/Full Board Renewal Form associated with your post review file # 6007982 in your Researcher Portal (https://eservices.queensu.ca/romeo_researcher/)

Reporting of Serious Adverse Events: Any unexpected serious adverse event occurring locally must be reported within 2 working days or earlier if required by the study sponsor. All other serious adverse events must be reported within 15 days after becoming aware of the information. Serious Adverse Event forms are located with your post-review file 6007982 in your Researcher Portal (https://eservices.queensu.ca/romeo_researcher/)

Reporting of Complaints: Any complaints made by participants or persons acting on behalf of participants must be reported to the Research Ethics Board within 7 days of becoming aware of the complaint. Note: All documents supplied to participants must have the contact information for the Research Ethics Board.

Annual Renewal: Prior to the expiration of your approval (which is one year from the date of the Chair's signature below), you will be reminded to submit your renewal form along with any new changes or amendments you wish to make to your study. If there have been no major changes to your protocol, your approval may be renewed for another year.

Yours sincerely,

[Signature]
Chair, Research Ethics Board
May 03, 2013

Investigators please note that if your trial is registered by the sponsor, you must take responsibility to ensure that the registration information is accurate and complete
Amendment Acknowledgment/Approval Letter

August 21, 2013

Mr. Brendan Coffey
School of Kinesiology & Health Studies
Queen's University

RE: File #6007982 PHE-132-13 A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work

Dear Mr. Coffey:

I am writing to acknowledge receipt of the following:

• Request for approval of the addition of a student workshop evaluation to better determine the effectiveness of the workshop training through increased sample size
• Notification of growth of the project to the national stage through the funded backing of the Paramedic Chiefs of Canada, and the Ontario Association of Paramedic Chiefs
• A copy of the information/consent form (Aug. 21, 2013)
• A copy of the consent form (Aug. 21, 2013)
• A copy of the recruitment poster

I have reviewed these amendments and hereby give my approval. Receipt of these amendments will be reported to the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board.

Yours sincerely,

[Signature]
Albert Clark, Ph.D.
Chair
Health Sciences Research Ethics Board
**Letter of Information**

“PHE-132-13 A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work”

This research is being conducted by Mr. Brendan Coffey and Dr. Steve Fischer in the School of Kinesiology and Health Studies (SKHS) at Queen’s University in Kingston, Ontario, and Dr. Renée MacPhee, in the Department of Kinesiology and Physical Education at Wilfrid Laurier University in Waterloo, Ontario.

**What is this study about?** The purpose of this research is to understand the physical occupational demands experienced by paramedics. You are invited to take part in a research study that will be completed in a two-step process. First, you will be invited to participate in a 6-hour workshop. The goal of the workshop is to help you learn how to conduct a physical demands analysis. During the workshop you will be instructed on the procedures and processes required to perform a physical demands analysis. Following the training, you will be asked to perform a mock physical demands analysis of an individual simulating job demands. Finally you will be asked to complete a follow-up test, via an online module, one week following the workshop. There are no known psychological, economic, or social risks associated with this study.

**Is my participation voluntary?** Yes. You should not feel obligated to conduct the physical demands analyses if it makes you feel uncomfortable. If you choose to withdraw, please announce to the researcher that you no longer want to continue. At that point, all of your electronic data will be deleted and any hard-copy data will be shredded.

**What will happen to my responses?** We will keep your responses confidential. Only experimenters will have access to this information. The data may also be published in professional journals or presented at scientific conferences, but any such presentations will be of general findings and will never breach individual confidentiality. Should you be interested, you are entitled to a copy of the findings.

**Will I be compensated for my participation?** You will not be monetarily compensated for participation in this study, however you will gain valuable practical experience with conducting a physical demands analysis, a valuable tool if you choose to pursue a career in ergonomics.

What if I have concerns? Any questions about study participation may be directed to the principal investigator, Mr. Brendan Coffey (1bc20@queensu.ca). You may also contact the co-investigators: Dr. Steven Fischer (steve.fischer@queensu.ca), and Dr. Renée MacPhee (rmacphee@wlu.ca), or Department Head of the SKHS Dr. Samantha King (kingsj@queensu.ca). If you have any concerns about your rights as a research participant please contact Dr. Albert Clark, Chair of the Queen’s University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board at (613) 533-6081. Please note that you may also keep this letter of information if you choose.

Again, thank you. Your interest in participating in this research study is greatly appreciated.

*This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen's policies.*
Consent Form

“PHE-132-13 A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work”

Name (please print clearly): ____________________________

1. I have read the Letter of Information and I have had all of my questions answered to my satisfaction.

2. I understand that I will be participating in the study called “A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work”. I understand that this means that I will be asked to attend a 6-hour workshop where I will learn how to conduct a physical demands analysis, and following the workshop, I will also be asked to perform a mock physical demands analysis of an individual simulating job demands and an online follow-up test one week later.

3. I understand that my participation in this study is voluntary and I may withdraw at any time. I understand that every effort will be made to maintain the confidentiality of the data now and in the future. Only experimenters in the Biomechanics and Ergonomics Laboratory at Queen’s University will have access to this information. The data may also be published in professional journals or presented at scientific conferences, but any such presentations will be of general findings and will never breach individual confidentiality. Should I be interested, I am entitled to a copy of the findings.

4. I am aware that if I have any questions, concerns, or complaints, I may contact the principal investigator, Mr. Brendan Coffey (1bc20@queensu.ca), co-investigators, Dr. Steven Fischer (steve.fischer@queensu.ca) and Dr. Renée MacPhee (rmacphee@wlu.ca), Department Head of the SKHS, Dr. Samantha King (kingsj@queensu.ca) or Dr. Albert Clark, Chair of the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board at (613) 533-6081.

I have read the above statements and freely consent to participate in this research:

Signature of Participant: ____________________________ Date: __________________________

Principal Investigator: ____________________________ Date: __________________________

Consent to Use Digital Images in Teaching, Presentations, and Publications

Sometimes certain images clearly show a particular feature or detail that would be helpful in teaching or when presenting the study results at a scientific presentation or in a publication.

I agree to allow digital images in which I appear to be used in teaching, scientific presentations and/or publications with the understanding that I will not be identified by name and that any facial features will not be discernible.

I am aware that I may withdraw this consent at any time without penalty. If consent is withdrawn, I ask that all digital images of myself be erased and removed from storage.

I am aware that if I have any comments or concerns resulting from my participation in this study, I may contact the principal investigator, Mr. Brendan Coffey (1bc20@queensu.ca), co-investigators, Dr. Steven Fischer (steve.fischer@queensu.ca) and Dr. Renée MacPhee (rmacphee@wlu.ca), Department Head of the SKHS, Dr. Samantha King (kingsj@queensu.ca), or I may contact Dr. Albert Clark, Chair of the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board at (613) 533-6081.

Signature of Participant: ____________________________ Date: __________________________

Principal Investigator: ____________________________ Date: __________________________
Letter of Information

“PHE-132-13 A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work”

This research is being conducted by Mr. Brendan Coffey and Dr. Steve Fischer in the School of Kinesiology and Health Studies (SKHS) at Queen’s University in Kingston, Ontario, and Dr. Renée MacPhee, in the Department of Kinesiology and Physical Education at Wilfrid Laurier University in Waterloo, Ontario.

What is this study about? The purpose of this research is to understand the physical occupational demands experienced by paramedics. The study will be completed in a two-step process. First, you will be asked to participate in a one day workshop (~8 hours). The goal of the workshop is to help you learn how to conduct a physical demands analysis on your paramedic colleagues. During the workshop you will be instructed on the procedures and processes required to perform a physical demands analysis. Following the training, you will be asked to perform a minimum of three physical demands analyses, as scheduled by your employer. Each physical demands analysis will require you to ride along with your paramedic colleagues for the length of a shift, during which time you will observe and record all of physical demands that are encountered. There are no known psychological, economic, or social risks associated with this study.

Is my participation voluntary? Yes. You should not feel obligated to conduct the physical demands analyses if it makes you feel uncomfortable. You may also withdraw at any time with no effect on your standing in your profession. If you choose to withdraw, please announce to the researcher that you no longer want to continue. At that point, all of your electronic data will be deleted and any hard-copy data will be shredded.

What will happen to my responses? We will keep your responses confidential. Only experimenters will have access to this information. The data may also be published in professional journals or presented at scientific conferences, but any such presentations will be of general findings and will never breach individual confidentiality. Should you be interested, you are entitled to a copy of the findings.

Will I be compensated for my participation? Yes. You will be compensated by your service, at your normal pay rate for the hours you participate (both training and when riding along to conduct the analyses).

What if I have concerns? Any questions about study participation may be directed to the principle investigator, Mr. Brendan Coffey (1bc20@queensu.ca). You may also contact the co-investigators: Dr. Steven Fischer (steve.fischer@queensu.ca), and Dr. Renée MacPhee (rmacphee@wlu.ca), or department head of the SKHS Dr. Jean Côté (je46@queensu.ca). If you have any concerns about your rights as a research participant please contact Dr. Albert Clark, Chair of the Queen’s University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board at (613) 533-6081. Please note that you may also keep this letter of information if you choose.

Again, thank you. Your interest in participating in this research study is greatly appreciated.

This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen’s policies.
Consent Form

“PHE-132-13 A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work”

Name (please print clearly): ________________________________________

1. I have read the Letter of Information and I have had all of my questions answered to my satisfaction.

2. I understand that I will be participating in the study called “A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work”. I understand that this means that I will be asked to attend a one day workshop where I will learn how to conduct a physical demands analysis, and following the workshop, I will also be asked to perform a physical demands analysis of paramedic work on three separate occasions.

3. I understand that my participation in this study is voluntary and I may withdraw at any time. I understand that every effort will be made to maintain the confidentiality of the data now and in the future. Only experimenters in the Biomechanics and Ergonomics Laboratory at Queen’s University will have access to this information. The data may also be published in professional journals or presented at scientific conferences, but any such presentations will be of general findings and will never breach individual confidentiality. Should I be interested, I am entitled to a copy of the findings.

4. I am aware that if I have any questions, concerns, or complaints, I may contact the principle investigator, Mr. Brendan Coffey (1bc20@queensu.ca), co-investigators, Dr. Steven Fischer (steve.fischer@queensu.ca) and Dr. Renée MacPhee (rmacphee@wlu.ca), department head of the SKHS, Dr. Jean Côté (jc46@queensu.ca) or Dr. Albert Clark, Chair of the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board at (613) 533-6081.

I have read the above statements and freely consent to participate in this research:

Signature: ___________________________ Date: ___________________________

Consent to Use Digital Images in Teaching, Presentations, and Publications

Sometimes certain images clearly show a particular feature or detail that would be helpful in teaching or when presenting the study results at a scientific presentation or in a publication.

I agree to allow digital images in which I appear to be used in teaching, scientific presentations and/or publications with the understanding that I will not be identified by name and that any facial features will not be discernible.

I am aware that I may withdraw this consent at any time without penalty. If consent is withdrawn, I ask that all digital images of myself be erased and removed from storage.

I am aware that if I have any comments or concerns resulting from my participation in this study, I may contact the principle investigator, Mr. Brendan Coffey (1bc20@queensu.ca), co-investigators, Dr. Steven Fischer (steve.fischer@queensu.ca) and Dr. Renée MacPhee (rmacphee@wlu.ca), department head of the SKHS, Dr. Jean Côté (jc46@queensu.ca), or I may contact Dr. Albert Clark, Chair of the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board at (613) 533-6081.

Signature: ___________________________

Name of Participant (Printed) ____________________________