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Universidade Europeia

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Doctoral Thesis

On-Site vs. Off-Site practices of MSD intervention and its impact on Organizational Productivity, Absenteeism and Costs. Theoretical analysis with application.

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II

On-Site vs. Off-Site practices of MSD intervention and its impact on Organizational Productivity, Absenteeism and Costs. Theoretical analysis with application.

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ABBREVIATIONS:

- ADHD: Attention Deficit Hyperactivity Disorder
- DALY: Disability Adjusted Life Years
- EI: Early Intervention
- FHP: Forward Head Posture
- HRA: Health Risk Assessment
- LBP: Low Back Pain
- LPS: Lost Productivity Score
- MBP: Mid Back Pain
- MSD: Musculoskeletal Disorders
- NP: Neck Pain
- WLQ: Work Limitations Questionnaire
- WPWP: Work-Place Wellness Programs
- YLD: Years Lost due to Disability
- YLL: Years of Life Lost

ABSTRACT:

Purpose: To establish to what degree musculoskeletal disorders (MSDs) impacted employee productivity, and to compare the impact of an On-Site, verses an Off-Site care strategy in the context of MSD related productivity losses, absenteeism and the associated costs.

Theoretical Foundation: MSDs have been shown to be the single greatest cause of long, short and permanent work disability globally and a primary driver of direct and indirect costs.

Presenteeism, has been shown to cost organization more in productivity losses than absenteeism or direct medical costs.

Methods: Two studies were performed to evaluate similar, seated computer-based employees from three large corporations. Productivity study, done in two phases to measure the impact that MSDs have on employee productivity and to measure the impact of the On-Site MSD treatment. The instrument used was; the WLQ or Work Limitations Questionnaire.

The Absenteeism study measured and compared absenteeism rates between employees who used the On-Site clinics in the past year, with employees with MSDs who chose Off-site options. An Absenteeism Questionnaire was used to measure MSD related absenteeism in the context of disability days, treatments, medical consults and diagnostics.

An average wage method was used to calculate the average cost per-year, per-case (employee).

Findings: Phase 1: WLQ average Lost Productivity Score of 10.5% which translated into an average total lost productivity cost of €1,478.25 per year. The Phase 2 follow up revealed the study group WLQ score dropped from 10.5% to 1.86% at a saving of €1,197.71 per person per year. The Control group average WLQ score was 11.2% and rose to 12.06%, or an additional loss of €118.13 per person per year.

Absenteeism study; Total average absenteeism in working hours per-person, per-year, On-Site vs. Off-Site were, 16.62 hours and 68.38 hours respectively costing €108.07 and €444.72 respectively. The average time an employee needed to wait, from the time of onset of symptom, to the time of first treatment, was 3.6 days (28.8 working hours) for On-Site and 14.09 days (119.2 working hours) for Off-Site respectively.

Conclusion: MSDs contributed greatly to costly employee productivity losses and presenteeism, and an On-Site treatment strategy significantly reduced productivity losses. The On-Site intervention demonstrated significantly lower absenteeism rates and lower disability rates, required fewer treatments, external consults and external diagnostics and less waiting time than employees seeking Off-Site care.

Originality: Measuring the comparative economic impact on organizations between On-Site and Off-Site treatment strategies for MSDs. This study measured productivity losses as presenteeism, and absenteeism, in terms of days and hours lost for medical treatments and exams as well as the impact of a presenteeism lowering strategies for MSDs.

Limitations: On-Site MSD clinics are rare. The sample did not represent the general Portuguese population. The average wage formula did not allow for actual costs. Study was not blinded.

Practical and Research Implications: The On-Site model can be used with larger samples representing a wider spectrum of the population which could potentially lead to a cost-effective strategy for the government (SNS), and a decreased burden on the health care systems.

KEY WORDS: *Work related musculoskeletal disorders (WMSD), On-Site Clinics, disability, absenteeism, presenteeism, productivity.*

1.0 INTRODUCTION:

1.1 Setting

Every day, millions of people around the world, perhaps including you the reader, suffer with nagging, chronic, aches and pains in their body, most commonly in their back and neck (Hoy, Brooks, Blyth, Woolf, Bain, Williams, Smith, Vos, Berendregt, Murray & Burstein, 2014; BMUS, 2014-2018), but also in their shoulders, wrists, hips, knees and ankles (Fit for Work, 2016). This suffering falls into a chronic disease category known as musculoskeletal diseases (MSDs). From the authors' perspective as a clinician with over 30 years' experience, the unfortunate reality is, most people only seek medical advice after they have been suffering for weeks, months and even years. Likewise, most people self-medicate with anti-inflammatory medications, pain killers or other self-remedies, and learn to "live with the pain", or have come to accept the pain in their neck, back or other body parts as "normal". This "normal" daily pain and suffering over long periods of time, is known as sub-clinical and chronic symptomology, which may eventually lead to a person seeking medical advice or attention when the suffering reaches the critical point at which they are unable to go to work one day or they are now dealing with a drug addiction to pain killers. It is only at this critical, and very late stage in the disease process, known as clinical symptom stage, that organizations become aware that a problem even exists, because a person didn't show up for work. It is only at this late stage that some, if any organizations, even measure or record the absent from work day, unless it extended beyond 3 working days, or the employee did not have a legitimate medical authorization (CIPD, 2016; Fit for Work, 2016; Folger, 2018). Organizations around the world, regardless of industry or size, will have at least one, if not hundreds of employees suffering with sub-clinical body pain at any given moment. There are no currently accepted methods or mechanisms to detect, predict or measure this sub-clinical employee suffering, or the impact it is having on organizations every day in lost productivity and unrecorded work-absence, until the problem becomes chronic and serious enough to seek medical attention (DMAA, 2009; Hoy et al., 2014; CIPD, 2016; Klepper, 2017; Folger, 2018; Middlesworth, 2017). Again, from the authors' clinical and professional experience, including previous Masters research in the corporate world (Hatch, 2014), as well as, addressing this sub-clinical pain and suffering epidemic in three large and enlightened organizations in Portugal since 2007, the author became aware that the managers within these organizations, in their day to day activities, have very little awareness

or concern for their own health, let alone, the health of their employees until it becomes a clinical or work-disability issue. Their professional lives are so full of other time pressures, responsibilities and regulation compliance, that employee health is outsourced to a third party, public or private medical facility for treatment and diagnoses. The companies that offer primary medical care within the workplace, rarely address MSDs beyond drug prescriptions (On-Site-OHS, 2017). This outsourcing to a third party (Off-Site) for consults, treatment and diagnostics, adds to the sickness absence and associated lost productivity of employees, but is rarely if ever truly measured by organizations (Hatch, 2014; BD, 2017; Genowska, 2017).

1.2 Previous work

Many people may agree that good health and a body free of pain would be considered as important contributing factors to a productive employee population and the resulting financial success of an organization. It would stand to reason that organizations looking to decrease absenteeism, improve productivity, employee performance and bottom-line results would consider employee health as a business strategy rather than a pure cost. If employee health was considered as a business strategy, it would also stand to reason that the persons charged with implementing such strategies would evaluate the primary health issues that may negatively be impacting employee health, performance and an organizations' bottom line. They would look to avoid, reduce or eliminate the primary health issues that were driving costs and reducing performance. To do so effectively, they would invest and allocate resources toward finding and implementing solutions that have proven to achieve the results they were looking for.

Though this argument may appear profound or obvious to the reader, the unfortunate truth is, most managers charged with finding solutions, do not allocate resources toward primary health related cost drivers but rather toward what is trendy at the time or what vendors offer as solutions to less costly problems. This task normally falls on the desk of the HR Director who is responsible for so many other administrative tasks that they may sometimes fail to fully research the solutions offered by vendors or health and benefits brokers. This trust in brokers can be an extremely costly mistake for the organization. The lack of understanding or solutions available for what truly drives costs and absenteeism within an organization is the problem. This paper seeks to expand upon how these conclusions were obtained later in this chapter.

This phenomenon raises some questions. One question is, what health issues are the primary direct and indirect cost drivers and causes of absenteeism and lost productivity for an organization? Another question is, are there existing, cost effective strategies that an organization could implement to address, reduce and prevent these costly health issues? Are there ways to improve existing strategies to be even more efficient and cost effective? The purpose of this dissertation is to address these questions. To bring awareness to a costly health issue, existing solutions for the issue and a comparison between different approaches.

More specifically the health issue being presented for this project is known as musculoskeletal disorders or MSDs. The most common workplace MSDs are low back and neck pain but also include several other painful conditions of the muscles and bones. Musculoskeletal Disorders (MSDs) are serious non-communicable diseases, being the primary cause of work disability and sickness absence and productivity losses worldwide (Fit for Work, 2013).

To learn more about the primary health challenges and cost drivers facing Human Resource and Benefits managers in large organizations, the author performed a qualitative study, the findings of which served as the foundation and starting point for this thesis. The research sample consisted of interviewees belonging to groups and subgroups associated with the Work-Place Wellness Program (WPWP) market space in the U.K., U.S. and Canada. It was essential to understand the perspective of the participants concerning MSD in the workplace and to explore the meaning they gave to this phenomenon. The literature search did not reveal any similar research involving interviewees from the workplace wellness space. There was genuine uncertainty as to why most stakeholders in this space lacked a strategy, solution or even awareness of work-related MSD and the impact on company performance, productivity and profits.

The interviewees consisted of thirty-six academically qualified professionals who worked for WPWP provider companies, HR, Benefits, Occupational Health and Safety departments within their respective companies. Also included, were, professional speakers, researchers and medical experts in the areas of workplace wellness, occupational medicine, work health and safety, in the U.S., U.K., and Canada. The chosen participants were purposive because they were likely to generate useful data for the research (Patton, 2002). The interviewees were chosen mainly because they were experts in WPWPs. They either researched, lectured or represented their respective companies on the WPWP subject, sold workplace wellness products and services to corporations

or were responsible for the purchase and implementation of WPWPs for their respective companies. The interviewees were also chosen based on the criteria that they came from different regions of their respective countries to see if there were cultural and regional differences or similarities. The idea was to create a maximum variation sample to ensure that the sample was credible and covered the main groups of interest for the research (Patton, 2002). Each of the interviewees also represented a variety of business sectors such as manufacturing, consulting, banking, construction, telecommunications, restaurants, hotels, retail, transportation, hospitals/medical centers and staffing agencies. This selection allowed for maximum variation or a sufficiently broad range of diversity for identifying common patterns or differences and similarities that cut across variations among the sample group for added credibility. Saturation was reached with the final chosen sample of twenty-eight interviewees because there were many thematic redundancies beyond that number. Personal interviews with thirty-six leaders in the workplace wellness space, of which, twenty-eight were the representative sample in the research paper, were performed in nine professional conference venues in the U.K. and U.S. between December 2013 and July 2014. The interviewees attended the conferences as one or more of the following; delegates, speakers, vendors or conference hosts/organizers.

Themes: interviews were coded and divided into the following themes.

1. *MSD Cost Awareness*
2. *Concern* about MSD.
3. *MSD Effects Awareness.*
4. *Strategy for WPWP &* MSD.

Figure 1 below is a Perceptual Map (Hatch, 2014) to visualize the findings of the research in graphic form in relation to the Themes: *Awareness of Costs, Effects & Concern about MSD* in the workplace by various stakeholders in the WPWP space and how those stakeholders ranked relative to the presence of business *Strategies* for MSD solutions.

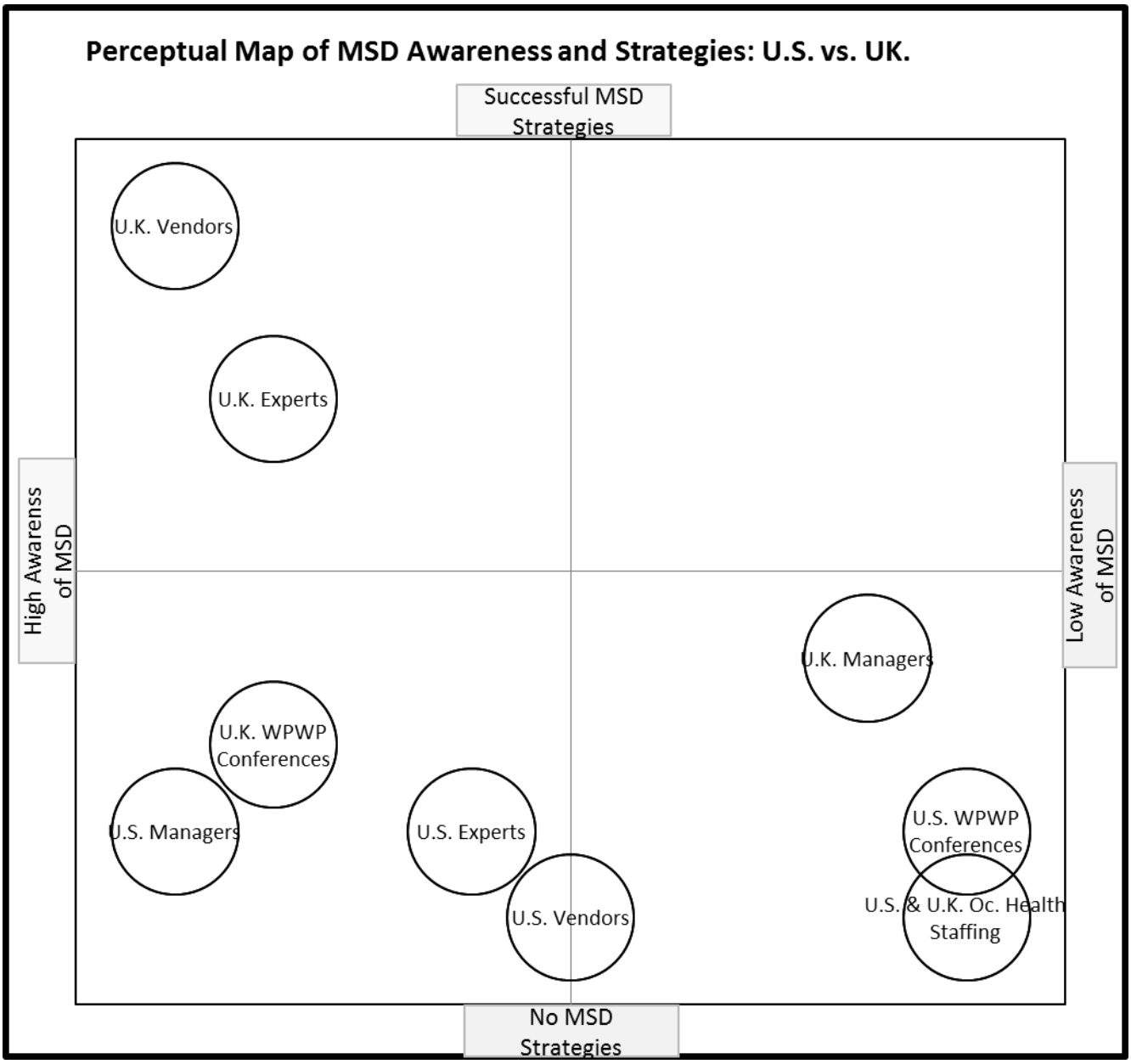


Figure 1 Perceptual Map of MSD Awareness and Strategies: U.S. vs. U.K (Hatch, 2014)

A crucial finding was, most of the specialists interviewed were highly aware that MSD was a serious and costly business problem except for U.S. WPWP vendors and job recruiters, yet few demonstrated concerns. Several interviewees whom worked for U.S. organizations consistently cited that MSD was a primary cost driver, being in the top three insurance claims for their own organizations, yet very few U.S. WPWP vendors provided or ever discussed with them, solutions for this problem. This was a common finding, primarily in the U.S. market. Most U.S.

interviewees acknowledged that MSD was a serious cost problem, yet few were aware of or implemented any direct MSD solutions to resolve it. Some managers and WPWP providers in the U.K. and the U.S. believed that MSD was only a problem for heavy labor sectors and manufacturing.

Most professionals in the U.S. and U.K. who had awareness of MSD solutions referred such cases to external medical, chiropractic and physiotherapy clinics for treatment. Few managers utilized On-Site MSD treatment or prevention solutions, and fewer still had methods for assessing the potential risk for MSD in their companies.

The U.K. vendors appeared to lead the U.S. in terms of MSD awareness in the work-place and offered more On-Site educational programs for prevention, back-care exercises and proper posture yet nearly all MSD clinical cases were referred externally Off-Site. The U.K. WPWP service providers appeared to have a higher awareness of the negative effects of MSD on a company's bottom line. Only two of the interviewees, from a research foundation in the U.K., were actively looking for solutions for workplace MSDs in Europe and the U.S.

Business groups on health and WPWP conference organizers in the U.S. demonstrated no focus on MSD yet organizers of U.K. based WPWP conferences often had at least one complete track dedicated to MSD awareness and solutions.

Most U.S. based WPWP vendors interviewed, offered web-based wellness solutions. They represented the mental, physical and social aspects of wellbeing but did not include MSD. The U.S. based near-site clinics mostly did not address MSD. Most U.K. vendors offered occupational health solutions, physiotherapy and ergonomic education, exercise programs and general wellness education solutions with a mixture being web-based, off site and On-Site. Again, the U.K. appeared more focused on MSD prevention and awareness strategies than the U.S. according to the interviewees.

Though more U.K. WPWP providers were aware of and addressed MSD, U.K. company managers had very little awareness, concern or knowledge about MSD as an indirect cost driver or cause of

lost productivity and absenteeism. The U.S. based company managers had higher awareness of the costs of MSD than their U.K. counterparts, primarily since U.S. companies were responsible for the health care costs of their employees. U.S. managers still did not express concern about the costs associated with MSD and focused primarily on controlling chronic diseases other than MSD, such as diabetes, obesity, high blood pressure etc., through web-based solutions. Such findings may have suggested disconnection between knowledge of MSD costs to companies and applied strategies to address MSD primarily in the U.S. market.

It appeared that the U.S. benefits managers, HR managers and wellness program managers charged with developing WPWPs for their companies were limited by what the WPWP vendors offered. U.S. vendors did not offer MSD solutions therefor, the managers in charge of developing programs did not include MSD as part of their program design. Another factor that surfaced was that the same managers took the vendors sales pitch at face value and did not investigate the validity of their claims. In the U.K. on the other hand, well organized physiotherapy networks focused on getting the employees of corporations to be treated in their network of clinics. The NHS in the U.K. paid for treating MSD. The U.K. and the U.S. corporations and governments both encountered ever increasing indirect medical costs related to MSD despite their efforts.

In Conclusion, it appeared that U.K. vendors were highly aware of the MSD problem in companies, but U.K. company managers had very low awareness or concerns. This is a complete contrast with the U.S. manager's very high awareness of insurance costs for MSD, but the vendors had no MSD solutions to offer them. Because of low management awareness of MSD in the U.K. and lack of solutions in the U.S., companies have not taken on MSD as a business purpose or strategy to reduce productivity losses, absenteeism and health related costs.

1.3 Missing from the literature:

As a complement to the study just mentioned, a literature review on work related MSD (WMSD) was performed. The review of the literature revealed that workplace wellness programs were a very popular option for cost containment, primarily in the U.S. The current workplace wellness model focused on chronic illnesses related to life-style choices that could be detected through screenings and addressed currently via on-line initiatives. Thus far the evidence showed that such programs made good business sense though there were conflicting opinions concerning direct ROI (Goetzel, Long, Ozminkowski, Howkins, Wang & Lynch, 2004; Archer, 2012).

The literature review on MSD in the workplace revealed that MSDs were costlier to business than all the other chronic illnesses combined when considering the indirect costs of lost productivity. The literature also revealed that less than 1 percent of WPWPs (Work-Place-Wellness-Programs) addressed this extremely costly issue of MSD even though several studies showed a higher ROI than most other programs (P.W.C., 2008).

More research needs to be done on the treatment of MSD in the workplace to determine the ROI for such services in a wide range of industries. More specifically, there needs to be studies on alternative approaches to addressing MSDs in the work-place, including, On-Site compared to Off-Site treatments, and to study the impact that MSDs have on employee productivity. Such studies also need to monetize the financial impact of lost productivity and absenteeism, beyond disability alone, and this study seeks to fill this gap in the research. The literature did not reveal any studies that evaluated absenteeism beyond full missed days from work. Absence days from work were typically the only measure of lost productivity. The literature also lacked studies that evaluated absence from work caused by medical consults and treatments or diagnostics. Missing from the literature were any correlational studies between specific MSDs such as low back pain, neck pain and resulting lost productivity. Studies that quantified the percentage of lost productivity for specific MSD conditions were also lacking from the literature.

The intention of this review was to build a business case for the detection, prevention and treatment of MSD in the workplace as a business strategy for a sustainable work force, retained earnings, and higher shareholder returns. The business could be across several industries as well as cross cultural because MSD in the workplace is a costly global epidemic (DMDA, 2009; Hoy et al., 2014; BMUS, 2014-2018).

This research fills the missing gaps in the literature by measuring the impact of MSDs on productivity and quantifying said impact as well as evaluating and measuring specific clinical findings as potential health risks that can potentially lead to lost productivity. We also add to the body of literature on MSDs and absenteeism by expanding the definition of absenteeism to include MSD related absence caused by treatments and consults.

1.4 Research question and objectives.

The research question of this thesis is: How do we compare On-Site versus Off-Site provision of MSD treatment in relation to organizations, namely on what concerns presenteeism/productivity/performance and absenteeism.

Further improvements to MSD intervention methods are needed and this research intends to do so by developing improvements in operational efficiencies and resource utilization, as well as improvements in the care delivery model. These changes include improvements in integrated clinical operations, standardized protocols, coordinated care and population health care management. The research is intended to show that a highly efficient, low cost, On-Site MSD early intervention program can achieve these objectives.

The research is based on the following hypothetical assumptions:

- MSDs are associated with lost productivity
- An On-Site MSD intervention can reduce productivity losses.
- On-Site MSD intervention programs result in less medical related absenteeism than off site MSD intervention.
- On-Site MSD intervention programs contribute to lowering the cost of absenteeism associated with Off-Site MSD interventions.

Figure 2 below is a summarized representation of the research model for this thesis.

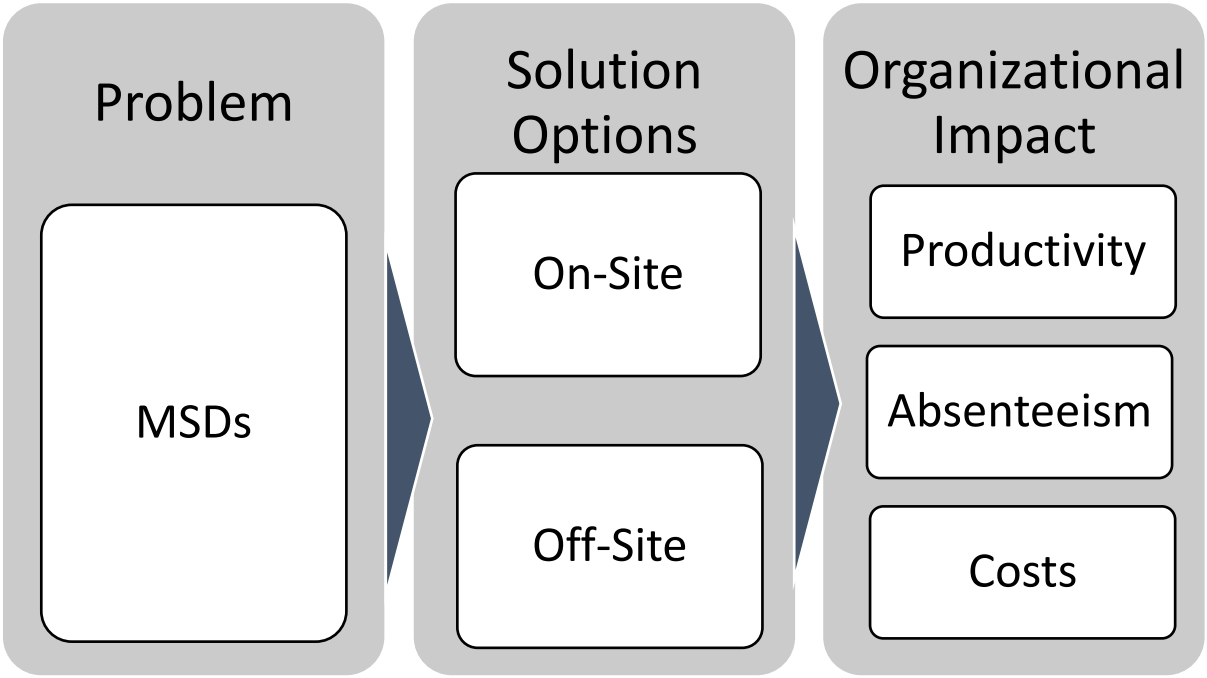


Figure 2 Summary of the Model

The following concepts will be discussed in depth: MSDs, work absence costs and On-Site & Off-Site clinics. The outcomes to be measured by the study will be the cost of absenteeism, as it relates to short term disability, clinical and diagnostic consults and treatment, as well as the cost of lost productivity or presenteeism as they relate to MSDs and if the On-Site intervention can reduce productivity losses.

Having the research question and the hypothesis in consideration, this thesis has a few objectives. Firstly, to bring attention to the global, national and organizational economic impact of MSDs (GCC, 2016), mainly back and neck pain (Hoy et al., 2014), and why early detection, intervention and prevention strategies should be a business management concern for all organizations (Fit for Work, 2016; Shortlister, 2019). Secondly, look deeply into other MSD associated health issues that start out simply as poor posture in early school years and lead to serious and costly health challenges, pain, suffering and lost productivity during the working years and beyond, further

strengthening the need and concern for predictive and preventive strategies (Deuchors & Edwards, 2007; Arnette & Pettijohn II., 2012). Thirdly, evaluate current, best practices of employer/organizational strategies concerning MSDs and other employee health issues, to learn which strategies are effective or not at impacting the organizations bottom line. Finally, the author seeks to measure to what degree, sub-clinical (unrecorded) and clinical (some-times recorded), workplace MSDs, specifically; neck pain, upper extremity pain, mid-back pain, low back pain and lower extremity pain, financially impact three organizations in Portugal, in terms of lost productivity (Lerner, Rogers, & Chang, 2005) and medically related absenteeism (Mitchel & Bates, 2007; Folger, 2018), as well as, compare the financial impact and outcomes between two strategies; On-Site MSD Clinics verses Off-Site MSD treatment, more specifically, in the absenteeism context of; disability, treatment, consults and diagnostics,. It is this comparison which adds originality to the body of academic knowledge, and contributes to management science, hopefully, making the MSD component of employee and organizational health management an accepted, best-practice, business strategy, for the efficiency and profitability of all organizations.

Accordingly, and in this context, the specific purpose of this research is to compare two different approaches to MSD intervention in the workplace namely *On-Site* interventions verses *Off-Site* interventions. More specifically we evaluate whether an On-Site intervention program offered to the working population, may reduce the impact of MSD-related absenteeism, and temporary work disability by getting employees to return to work earlier or contribute to reducing missed work all together as well as improving productivity.

Finally, the study relates to the future objectives of this research, in the context of the European NHS's, is to bring together the private and public sectors so that both parties can benefit from an On-Site intervention strategy for MSDs. By splitting the costs of establishing and operating an On-Site clinic, the public-sector health systems will reduce costs by reducing medical consults, surgeries, unnecessary diagnostic testing, and reduce social security payments for short and long-term work disability from missed days' work. The private sector will have the benefits of a healthier workforce, reduced absenteeism, increased productivity and increased market competitiveness as well as increased shareholder returns and company profits.

It is also interesting to remind since the offset of this research that On-Site MSD interventions can be beneficial across stakeholders (Fit for Work Europe, 2013; 2014), namely:

- For those living with MSDs, On-Site intervention programs can help improve patient functionality, work ability and work productivity.
- For a Healthcare Professional, On-Site MSD intervention programs can facilitate timely, accurate patient flow, diagnosis and treatment, while helping to improve patient outcomes.
- For Health Systems, Hospitals, On-Site MSD intervention programs can help to improve efficiency and effectiveness of healthcare organization and delivery by freeing up emergency rooms and clinics for more urgent health conditions.
- From an employer perspective, On-Site MSD intervention programs can be useful in maintaining work ability and work productivity, thereby, helping to minimize presenteeism and absenteeism.
- For government, On-Site MSD intervention programs can provide a preventive pathway that enhances health and work ability and potentially avoids additional social and welfare outlays.

1.5 Methods

The research used a Correlational (posteriori control) design which allowed for comparison and contrasting of research findings between multiple cases with similar natural environments. A comparison of MSD related work absence and lost productivity among similar employee populations in similar industries, the only significant variable being the use of On-Site or Off-Site interventions/treatments.

Other variables included are the types of industries and the average ages of the respective populations that were studied. Such non-manipulable variables included a comparison between white collar, sedentary workers such as energy providers, consulting and banking.

The real-world evidence research evaluated the patients from three large organizations in Lisbon Portugal that have On-Site MSD intervention clinics. It was an analysis of primary data collected from two self-completion questionnaires aimed at evaluating the impact that an On-Site MSD intervention program has on absenteeism, productivity, decision making, energy levels, interaction with colleagues and engagement of work tasks. In compliance with real world evidence (RWE)

research standards, clinical data was collected from the electronic health records of each subject in the productivity study (Sun, Tran, Tang, Guo, & Li, 2018).

Upon completion of the study, the data should help to reveal if an On-Site MSD intervention program can yield better or worse outcomes than the existing Off-Site MSD intervention models. If the research can discover a consistently greater positive outcome than existing models, the research will reveal a business strategy with benefits among all stakeholders and a growth market opportunity for MSD interventions and prevention.

1.6 Plan of the thesis:

Accordingly, the thesis has the following five sections. In section 2 we expose the three concepts that are part of the research question namely, MSD diseases and impact on organizations (absenteeism, productivity, work disability and expenditures… In section 3 we expose theories that exist relating the three concepts and define a specific model with hypothesis. In section 4 we expose similar cases that were studied to establish our methodology. Part B represents the Empirical Study. Section 5 describes the context of the organizations studied. Section 6 describes the methods used for the study as well as the instruments used and their implementation. Section 7 describes the results of the study. Section 8 is a discussion of the study results, practical implications and limitations. Finally, in section 9 we expose the conclusions, practical applications of the study and venues for further research.

PART A. LITERATURE REVIEW

The literature review is a deeper look into the concepts, theories and studies surrounding MSDs. More specifically, chapter 2 begins with the profound global economic and organizational impact of MSDs, followed by a section on the serious physical and emotional impact of poor posture to our health, and how poor posture directly translates into several health challenges which can negatively impact employee productivity. Furthermore, in section 2, the concept of productivity is discussed; how it is defined by organizations, how it is measured, including the concept of presenteeism, and more specifically, some components of productivity in the workplace, including; decision making, energy levels, interaction with colleagues and ending with the hypotheses of this study surrounding productivity. Finally, section 2 dives into the concept of employee absenteeism; how it is defined by organizations, how it is measured, as well as the causes and costs associated with it, ending with the hypotheses of this study concerning absenteeism.

Section 3 goes into a detailed review of the theory and practice of workplace wellness programs (WPWPs), more specifically their historical origins, purpose and focus as well as business aspects such as; costs, ROI, and strategies. Furthermore, the review looks at the concept of On-Site MSD intervention models, benefits and practical social implications as well as a look at the subject of Health Economics and how MSD plays a role.

Section 4 is a review of 21 known studies divided into 10 Off-Site intervention studies for MSDs, which sets the stage for the socio-economic benefits in a variety of countries surrounding an early intervention strategy for MSDs, and 11 On-Site clinic studies which demonstrate an impact on employee health, productivity and the organizational bottom line. The section ends with a study that specifically measures productivity/presenteeism losses and absenteeism associated with a variety of health issues, using the research instruments, WLQ, chosen for this thesis study.

2.0 CONCEPTS:

2.1 MSDs: Global Economic and Organizational Impact.

Why should MSDs be considered by managers as a business strategy and concern? It is important to put the social and economic impact of MSD into the proper context and perspective.

Musculoskeletal conditions such as low back pain, neck pain and arthritis affect more than 1.7 billion people worldwide and have a greater impact on the health of the world population (death and disability) than HIV/AIDS, tropical diseases including malaria, the forces of war and nature, and all neurological conditions combined (Rheum, 2014; GBD, 2010; NHIS, 2012; CDA, 2015; Putrik, Ramiro, Chorus, Kezei, & Boonen, 2018; Hulshof, Colosio, Daams, Ivanov, Prakash, Kuijer, Leppink, Mandik, Masci, van der Molen, Neupane, Nygard, Oakman, Pega, Proper, Pruss-Ustin, Ujita & Fringes-Dresen, 2019).

Musculoskeletal conditions represent the sixth leading cause of death and disability, with only cardiovascular and circulatory diseases, neonatal diseases, neoplasms, and mental and behavioral disorders accounting for more death and disability worldwide (Lancet, 2013; Hulshof, et al., 2019). When combined with neck pain, painful spinal disorders are second only to ischemic heart disease in terms of their impact on the global burden of disease. Spinal disorders have a greater impact than HIV/AIDS, malaria, lower respiratory infections, stroke, breast and lung cancer combined, Alzheimer's disease, diabetes, depression or traffic injuries (Lancet, 2013; Hulshof, et al., 2019). Current estimates suggest that 632.045 million people worldwide suffer from low back pain and 332.049 million people worldwide suffer from neck pain (Hoy, 2014; Putrik, Ramiro, Chorus, Kezei, & Boonen, 2018).

MSD, primarily back pain, is the single greatest cause of work disability, accounts for over 50% of work absences and for 80% of permanent work incapacity (Fit for Work, 2013; Lietz, Kozak, & Nienhous, 2018; Hulshof, et al., 2019). This puts a tremendous strain on government resources (BMUS, 2013). With MSDs costing industrialized nations billions of dollars each year in productivity losses, millions of days of absenteeism and burdening inefficient health care systems, there is a tremendous need for cost containment and cost avoidance solutions related to MSD (Fit for Work, 2013; 2014).

In the U.S., the socioeconomic impact of lost work time and wages associated with MSD in 2011 were significant. The cost to treat injuries in hospitals alone was $83.1 billion (HCUP 2011). In

2012, 291 million work-days were lost due to back and neck pain (NHIS 2012). This was 3 days longer off work than for other types of workplace injuries (BLS 2008-2010).

Research by the Council for Disability Awareness (CDA) revealed the most common cause of disability claims was MSD which accounted for over 30% of total current claims in 2012. The list below provides the other most common causes of disability such as cancer, work injuries, mental illness and cardiovascular disorders. The actual cost economically, socially and emotionally of MSDs and associated pain is greater than all the other causes of disability combined. The main results of the Council for Disability Awareness questionnaire on common causes of disability are the following:

- CDA's 2013 Long-Term Disability Claims Review12, the following were the leading causes of new disability claims in 2012:
    - ***Musculoskeletal/connective tissue disorders (28.5%) ****
    - Cancer (14.6%)
    - Injuries and poisoning (10.6%)
    - Mental disorders (8.9%)
    - Cardiovascular/circulatory disorders (8.2%)
- The most common causes of existing disability claims in 2012 were:
    - ***Musculoskeletal/connective tissue disorders (30.7%) ****
    - Disorders of the nervous system and sense organs (14.2%)
    - Cardiovascular/circulatory disorders (12.1%)
    - Cancer (9.0%)
    - Mental disorders (7.7%)

According to the Bone and Joint Initiative in the U.S. (BMUS, 2014-2018) MSD was the leading cause of disability in 2010. One in two adults were affected (126.6 million), twice the rate of chronic heart and lung conditions (NHIS 2012). The average annual cost for treatment per person in the U.S. was $7,800. The combined annual cost for treatment and lost wages was estimated between $796.3 billion and $874 billion or 5.7% GDP, (MEPS 2011, BMUS 2014). The most

prevalent MSDs were arthritic and related conditions, back and neck pain and injuries from falls, sports and the workplace. The most prevalent of all conditions suffered was low back and neck

pain which accounted for 75.7 million adults (NHIS 2012). MSDs accounted for 18% of all health care visits in 2010 of which 52 million were for low back pain alone (HCUP, 2011; NHDS, 2010).

The health system has yet to produce an effective strategy of absence avoidance or returning people to work quickly. To address this issue, the European Union commissioned research in early intervention (EI) (Fit for Work, 2013). EI consisted of specific protocols performed in EI specific hospitals and clinics. The findings concluded that implementation of the program, offered to the general population, improved short and long-term work disability outcomes and was cost-effective (Fit for Work, 2014). Is there a better way?

The following is a brief description of DALY, YLL, YLD to help bring understanding and true value to the seriousness of a given disease.

A DALY is a disability adjusted life year. It was developed in the 1990's as a method used to measure the overall burden a disease has on a population in terms of overall health, and life expectancy compared to other countries. The measurement is calculated using the number of years lost due to disability, poor-health or early death (World Health Organization, 2008).

According to the World Health Organization (2015), one DALY is an expression of one lost year of "healthy" life because of a certain disease. The sum of disease burdens or the DALY's of an entire population measures the gap between what is considered ideal health, free of disability or diseases and what the actual current health status of a population is. DALY's for health conditions or diseases are measured as the sum of two factors; Years of Life Lost (YLL) due to premature deaths in a population and the Years Lost due to Disability (YLD) for people living with the consequences of the health condition or subsequent disability (Mangen, 2013). Therefor a DALY = YLL + YLD, or, one DALY is equal to one year of healthy life lost.

Out of all 291 conditions studied in the Global Burden of Disease 2010 Study, low back pain ranked highest in terms of disability (YLDs), and sixth in terms of overall burden (DALYs), (Hoy, et al., 2014). DALYs increased from 58.2 million (M) (95% CI 39.9M to 78.1M) in 1990 to 83.0M (95% CI 56.6M to 111.9M) in 2010. Prevalence and burden increased with ages (Hoy et al., 2014).

The conclusion of Hoy's research study was that low back pain caused more global disability than any other condition (Hoy et al., 2014).

According to studies by the 2000-2010 Bone and Joint Decade Task Force on Neck Pain and Its Associated Disorders with findings presented in the Global Burden of Disease 2010 report, when considering death and disability in the health equation, musculoskeletal disorders cause 21.3 percent of all years lived with disability (YLDs), second only to mental and behavioral disorders, which account for 22.7 percent of YLDs (Haldeman et al., 2009). Low back pain is the most dominant musculoskeletal condition, accounting for nearly one-half of all musculoskeletal YLDs (Haldeman, Caroll, Cassidy, Schobert, Nygren, 2009; Hoy et al., 2014). Neck pain accounts for one-fifth of musculoskeletal YLDs (Haldeman et al., 2009; Hoy et al., 2014).

Musculoskeletal conditions represent the sixth leading cause of death and disability, with only cardiovascular and circulatory diseases, neonatal diseases, neoplasms, and mental and behavioral disorders accounting for more death and disability worldwide (Haldeman et al., 2009; Hoy et al., 2014; Putrik et al., 2018; Lietz, Kozak, & Nienhous, 2018). Low back pain is the sixth most important contributor to the global disease burden (death and disability) and has a greater impact on global health than malaria, preterm birth complications, COPD, tuberculosis, diabetes or lung cancer (Haldeman et al., 2009; Hoy et al., 2014). When combined with neck pain (21st most important contributor to the global disease burden including death and disability), painful spinal disorders are second only to ischemic heart disease in terms of their impact on the global burden of disease (Haldeman et al., 2009; Hoy et al., 2014; Putrik et al., 2018). Current estimates suggest that 632.045 million people worldwide suffer from low back pain and 332.049 million people worldwide suffer from neck pain (Haldeman et al., 2009; Hoy et al., 2014; Putrik et al., 2018).

"The Global Burden of Disease Study provides indisputable evidence that musculoskeletal conditions are an enormous and emerging problem in all parts of the world and need to be given the same priority for policy and resources as other major conditions like cancer, mental health and cardiovascular disease…" (Haldeman et al., 2009). A specialist in work-site ergonomics and prevention strategies for MSD stated; “Despite information on musculoskeletal disorder (MSD) prevention widely published and no shortage of strategies and solutions available in the marketplace, well-meaning people and organizations still struggle to effectively manage musculoskeletal health” (Middlesworth, 2017; Amin, Fatt, Quek, Oxley, Noah, & Nordin, 2018; Lietz et al., 2018).

2.1.1 Posture as a Health Risk:

Research demonstrates that there is a direct link between Poor Posture, MSDs, Health and Business and this section seeks to explore some of the consequences of chronic poor posture in the workplace.

This section is intended to bring context and clarity as to why an MSD prevention and intervention program address posture in the workplace. Chronic poor posture in the workplace is the starting point and catalyst for the sub-clinical and chronic neck and back pain that is so prevalent within organizations that leads to the use of medications, lost productivity and absenteeism.

A focus on posture is the primary clinical methodological approach to the treatment and prevention of MSDs in the workplace. Several research studies are available that link poor posture to diseases beyond low back pain and neck pain. It is the authors opinion that the low back pain and neck pain experienced by employees are merely symptoms and warning signs to potentially more serious and costly health challenges such as heart disease, pulmonary disease, diabetes, high blood pressure etc., which are currently the focus of employee health screenings and WPWPs. To treat only the symptom and not the cause is a disservice to the employee/ patient and an inadequate cost avoidance strategy for the employer as well as a contributing factor to ever increasing health care costs.

MSDs are a major socioeconomic cost driver with low back pain and neck pain as the primary causes of disability globally as stated previously. More alarming is the research pointing to poor posture and associated pain as the cause of pathological consequences such as a decrease in gray matter in the brain and several health risks such as decreased lung capacity, increased blood pressure, fatigue and even premature aging. These serious consequences are devastating to a company's performance and global competitiveness as well as nations with aging populations. This section will touch briefly on several research studies that link poor posture to poor health, dysfunction and disease. This chapter alone could serve as a business case for On-Site MSD prevention and intervention as an appropriate and logical business strategy.

2.1.1a Brain:

Let us start with the brain. The world is currently facing an epidemic of degenerative brain disorders such as Alzheimer's and other forms of dementia as the baby boomer generation, those people born between 1945 and 1964, are all over the age of 50. Currently, modern medicine has

not found a cure for these brain diseases thus preventive strategies are a logical consideration. How is posture related to brain degeneration? According to one study (Apkarian, Sosa, Sonty, Levy, Harden, Parrish & Gitelman, 2004), patients presenting with chronic low back pain demonstrated 10-20 times more loss of gray matter than the healthy control group based on MRI examination of the brain. The loss of gray matter was directly associated with the chronicity of the pain, in some cases, with up to a 1.3 cm loss of gray matter for every year of chronic pain. The gray matter of the brain includes regions of the brain that control the muscles of the body, memory, emotions, self-control, speech, decision making ability and sensory functions such as seeing and hearing (Miller, Alston & Corselles, 1980). Indeed, such brain functions are necessary for employee productivity.

2.1.1b Heart & Lungs:

A very common postural distortion occurs when people spend many hours per day sitting and working in front of computer screens. This postural distortion is known as Forward Head Posture (FHP) or Forward Head Carriage (FHC) as shown in *Figure 3* below. FHP can cause a reduction in lung capacity by as much as 30% by adding up to 30 pounds (14 kilos) of abnormal leverage on the spine (Cailliet & Gross, 1987). This lost lung capacity can lead to more serious long-term health effects such as heart and blood vascular disease.

2.1.1c Forward Head Posture (FHP)

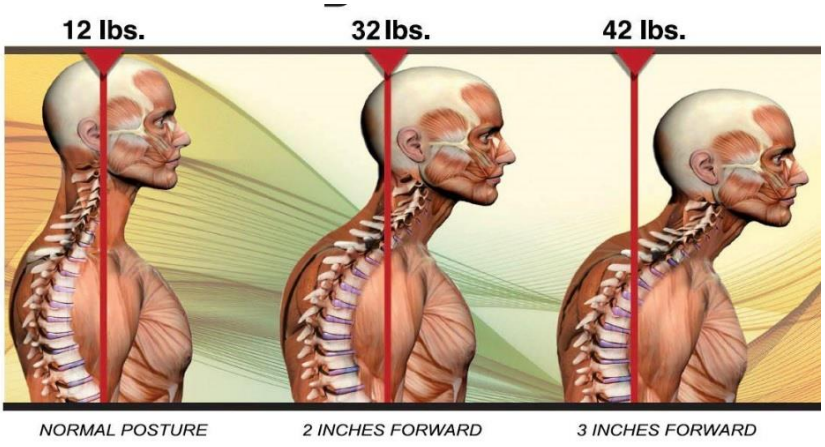


Figure 3 Example of FHP

Figure 3 above represents forward head posture (FHP)(www.erikdalton.com, 2010). The image demonstrates the tremendous increase of strain on the neck, the further the head is in front of the

shoulders. This has become an ever increasingly common phenomenon is society since the advent of personal computers, especially hand-held technology (Physiopedia, 2019). A correlation has been found between the muscles in the neck, FHP and their influence on blood pressure and heart rate (Edwards, Dallas, Poole, Milligen, Yanagawa, Szabo, Erdelyi, Deuchars, S. & Deuchars, J., 2007). FHP and resulting abnormal muscle tone put stretching forces on the fragile tissues of the brain stem that control cervical paraspinal musculature and were found to cause irregular heart rate and increased blood pressure (Edwards et al., 2007). Proper posture and spinal alignment were shown to have a positive systemic impact on the patients' vascular health. More alarming is the clinical finding of early-onset arthritic changes, neck pain and headaches in children who have yet to fully develop (Physiopedia, 2019).

A group of Brazilian researchers found that proper posture improvements can lead to open airways and decrease the effects of asthma (Almeida, Guimarães, Moço, Menezes, Mafort & Lopes, 2013). The researchers observed how abnormal postural adaptations of asthmatic patients demonstrated shortening of the respiratory musculature. These patients with persistent asthma have been shown to have postural distortion patterns that increase airway resistance, making breathing more difficult. The study demonstrated that the severity of the asthma symptoms can be reduced if proper posture correction was introduced as part of the patients' treatment regime (Almeida et al., 2013).

2.1.1d Muscle Wasting:

Due to the sedentary nature of prolonged passive sitting and the consequential pathologic health effects, sitting has been labeled the "new smoking". A former NASA physiology researcher, in her book; "Sitting Kills, Moving Heals: How Everyday Movement Will Prevent Pain, Illness, and Early Death—and Exercise Alone Won't" Joan Vernikos PhD writes; "It's actually the change in posture that is the most powerful in terms of having a beneficial impact on your health, not the act of standing in and of itself"(Vernikos, 2011). In other words, it is important to change positions several times throughout the day to introduce movement into your spine and surrounding musculature. The study supports the link of poor posture with sluggishness, diminished health returns and postural collapse associated with sitting for many hours (Vernikos, 2011).

2.1.2 Human Performance:

Posture is the foundation for good health and human performance. The following studies relate to human performance in terms of muscular efficiency, balance, stability and strength associated with posture.

2.1.2a Balance and Coordination:

A study demonstrated that people with low back pain move differently than people without pain thereby leading to different postural stabilization patterns or compensations in movement (Jones et al., 2012). The patient was believed to be moving differently to avoid pain but may also reflect underlying dysfunctions that may be contributing to the recurrent low back pain episodes.

Improper neck alignment has been shown to alter proprioception and normal movement. Proprioception is our bodies ability to balance and to have awareness where our bodies and or body parts are in space. Special neurological receptors in the joints of the spine and other joints send constant feedback signals to the brain. When a joint is out of alignment these special receptors send inaccurate messages to the brain thus causing the muscles to respond inappropriately which leads to postural distortions and compensations. Another study was performed to explain the relationship between neck alignment and the perception of the body during static and dynamic orientation (Pettorossi & Schieppati, 2014). The authors demonstrated that the subject's mental representation of space was altered because of altered cervical spinal motion patterns, motor responsiveness and head position. Such responses over time lead to adaptations referred to as plasticity or altered neurological responses resulting in altered neurological pathway formation. The signal from the altered joint or muscle sends a message to the brain telling it that the body part is in a position different than the actual physical location. As an example, a person may close their eyes while standing and the researcher can ask them where their feet are pointing and to match that positioning with their hands. When asked to open their eyes to compare the position of their feet and hands, the subject is often surprised to see that their feet are in a very different position than their mind perceived. Such misperceptions lead to chronic movement dysfunctions that can lead to pain and premature joint degeneration and aging also known as MSD.

2.1.2b Headaches & Fatigue:

Another factor in human performance is one's mental state. A study demonstrated that 70% of subjects suffering from headaches also demonstrated cervical spine dysfunction (Lee et al., 1995).

The research also demonstrated that correct functional alignment of the cervical spine resulted in decreased fatigue, enhanced performance at work and an improved mental state. The correction of FHP resulted in less pain and muscle tension and stiffness in the neck as well as the jaw, shoulders and back (Lee et al., 1995; Goldstein & Makofsky, 2016). Approximately 50% of the population suffers from cervical pain or headaches (Goldstein & Makofsky, 2016).

2.1.3 Prevention:

The prevention of chronic illness is directly related to lifestyle choices. Good postural habits result in proper spinal joint alignment, good balance, and proper biomechanical function of the body thus avoiding premature aging of the body that leads to chronic illness.

2.1.3a Early Mortality:

Early mortality has been directly associated with an increased thoracic kyphosis. (An excess curvature of the Thoracic/Dorsal spine). It has been demonstrated that there is a significant correlation of hyperkyphotic spinal posture as a predictor of early mortality in older men and women (Kado, Lui, Ensrud, Fink, Karlamangla & Cummings, 2009). Researchers postulated, if poor posture and increased thoracic kyphosis resulted in early mortality, proper posture should be related to increased longevity (Kado et al., 2009). A later study concluded that the presence of an increased kyphosis in elderly women showed a 1.14-fold increased risk of death independent of the presence of spinal vertebral osteoporosis (Kado et al., 2009). There was also a correlation of hyperkyphotic posture and injurious falls in older persons (Kado et al., 2009). Elderly subjects who present with hypokyphosis are more vulnerable to suffering serious injuries because of falls due to a decrease in stability and balance controlled by the body's proprioceptive systems.

2.1.3b Heart Attack:

Loss of vertebral height caused by poor posture has been linked to increased risk of heart attack. A 20-year British study found on average, men lose 1.67cm in height and men who lost 3cm in height were 64% more likely to die of a heart attack even if these men had no previous history of cardiovascular disease. (Wannamethee, Shaper, Lennan, & Whincup, 2006). This is a good argument for maintaining good posture as a preventive measure against heart attack.

2.1.4 Childhood Development:

To approach health and wellness from a truly preventive perspective, it is worth looking at the association of posture and how it impacts the children of our society. If correcting posture in

children positively impacts their health and performance, it stands to reason that such approaches will ultimately impact future generations of the employee workforce thus preventing or reducing many future MSD and posture related challenges all together from a broader economic perspective. The following studies include school performance, and attention deficit hyperactivity disorder (ADHD).

2.1.4a Neck Pain & Backpacks:

There is a direct correlation between three factors; forward head posture (FHP), back pack weights, and disability in school aged children due to neck pain (Cheung et al., 2010). Simply stated, children who carry backpacks that are too heavy for them, present with FHP which leads to neck pain and resulting disability. According to the American Occupational Therapy Association, a child's backpack should only be 10% of their body weight or less. (AOTA, 2015). This study demonstrated how and why many young people enter the workforce with posture related neck and low back pain thus enforcing the importance and need for schools and parents to teach postural hygiene from a young age as a preventive strategy.

2.1.4b Back Pain & School Performance:

A study of 270 children in Finland found a direct correlation between poor academic performance and poor posture. The study found that children with reported neck and or low back pain had poorer school performance than the asymptomatic children. The researchers concluded: To improve school performance, children who maintain alert upright posture have the advantage over their classmates. Not only is upright posture the most intelligent posture, it also prevents neck and back pain which can distract students from their studies. (Salminen, 1984). One can safely conclude that the same correlation between posture and performance translates into the working population.

2.1.4c ADHD:

A researcher used therapy balls in a study with Autistic children as well as with children with attention deficit hyperactivity disorder (ADHD) (Schilling, 2004). These school children who were previously diagnosed with ADHD demonstrated improved productivity and behavior when sitting on therapy balls versus traditional chairs. The research demonstrated that both teachers and students preferred the therapy balls. The therapy balls activate the spinal muscles and improve posture. Proper posture impacts brain function which impacts motor and cognitive performance

which translates into increased attention span thus allowing the children to succeed academically and improve social behavior thus allowing for improved interaction with classmates and teachers (Schilling, 2004).

2.1.5 Psychological and Physiological Effects of Posture:

There is a direct correlation between psychological states and physiological processes and how they are impacted by posture. Several research studies demonstrate how posture is the physical embodiment of cognitive processes, attitude and emotional states. The following research studies demonstrate how one's posture presentation impacts one's mental perceptions, confidence, self-worth, power and feelings of dominance by impacting the production of mood-altering hormones.

2.1.5a Posture & Human Physiology:

People can alter their physiology by altering their posture. A posture described as a power pose is expressed with an open and expansive stance, hands on the hips, chest sticking out, also known as the "Super Man" pose (Carney, Cuddy, & Yapp, 2010). People with feelings of powerlessness express with closed and constricted postures. A study by Carney et al., 2010, demonstrated that subjects who maintained a power posture, even as little as two minutes can change their physiology to become more powerful. The subjects had hormone levels measured by a saliva test. The scientists concluded that the power postures "cause neuroendocrine and behavior changes [including] elevations in testosterone, decreases in cortisol, and increased feelings of power and tolerance for risk", (Carney et al., 2010). An increase of the hormone, testosterone, increased self-confidence and risk taking while an increase in the hormone, cortisol, is associated with stress. The opposite was true for the postures of powerlessness. The researchers concluded that subjects with proper posture embody self-confidence and power due to neuroendocrine changes in physiology (Carney et al., 2010).

2.1.5b Confidence and Posture:

Posture has also been shown to impact cognitive processing. Subjects who adopted the previously described power posture have reported higher levels of self-perceived leadership and self-confidence. There is a psychologic connection of posture, indicating that body posture affected the cognitive and emotional states of subjects (Arnette & Pettijohn, 2012). The study also demonstrated that a higher perception of leadership was also correlated to the subjects' demeanor when making important decisions and during interviews or decision making (Arnette & Pettijohn,

2012). This study was based on observation and self-reported perceptions of feelings but did not include the measurement of emotion altering hormones as seen in the previously described study.

2.1.5c Posture and Mental Perception:

Based on the self-validation hypothesis studies; "body postures can impact persuasion by affecting the direction of thoughts" from negative to positive (Briñol, Petty, & Wagner, 2009). The researches divided the study subjects into two groups. One group was asked to sit with proper posture and the other group with slumped posture and asked to self-evaluate their best and worst characteristics. The study concluded that the participants who presented with an erect posture (upright, chest out and shoulders back) had a more positive state of mind and a confident self-image (Briñol et al., 2009). The researchers found that posture embodied self-evaluation and attitude. Studies have shown that subjects with correct posture had more positive self-image characteristics while the group with poor posture reported more negative characteristics than positive (Briñol et al., 2009). Posture has also been shown to impact social problem solving, self-esteem and optimism (Nielsen, 2017). The human qualities of self-validation, positive or negative emotions, optimism and self-esteem in theory, have an impact on the performance and productivity of the workforce.

2.2 Intervention – On Site versus Off site

In simple terms, the difference between "On-Site" and "Off-Site" is that for On-Site, the company has built an actual clinic at the location where their employees work. This is typically done for convenience. Companies, primarily in the manufacturing sectors with large populations began providing primary care to their employees at the work site to screen for health risks and monitor medication compliance as well as attend to non-life-threatening health issues or injuries. They became known as "employee sponsored clinics". On-Site clinics that offer additional health services such as health coaching, diet, exercise, stress management, work-life balance etc. are known as Work Place Wellness Programs (WPWPs) which will be discussed later.

"Off-Site" in the context of this study, is any other health care facilities, clinics or hospitals that provide diagnostics and treatments for health conditions that are not at the location where the employees work.

In the case of "On-Site" clinics, very few offer treatments for MSD, thus, the clear majority, over 95%, offer only primary care (PWC, 2008; On-Site-OHS, 2017). What is an On-Site employee

sponsored primary care clinic? An On-Site employee sponsored primary care clinic typically provides easy access to a wide range of primary care and urgent care services for non-life-threatening illnesses or injuries in the workplace. They typically focus on disease prevention, health promotion and wellbeing services, immunizations as well as occupational medicine services. On-Site clinics are like a traditional doctor's office or urgent care clinic for treating a variety of conditions such as sinus infections, cuts and scrapes, common cold and stomach viruses etc.

Evidence supports the notion that using On-Site clinics to provide primary care and health coaching to promote behavioral changes that improve chronic conditions is a better use of healthcare resources (Chenoweth, Martin, Pankowski, & Raymond, 2005,2008; Tao, Chenoweth, Alfriend, Barron, Kirkland & Scherb, 2009).

Typical Primary Care Clinic Services in the United States:

- *Diagnoses and treatment of illnesses*
- *Occupational treatment*
- *Management of chronic illnesses*
- *Immunizations/flu shots*
- *Physical examinations*
- *Routine health screenings (blood pressure, cholesterol, blood sugar, body weight)*
- *Preventive care*
- *Management of chronic conditions (typically medication management)*
- *Coordination of care with Off-Site clinics.*
  (On-Site OHS, 2017)

Large employers have implemented On-Site health clinics for decades, prompted in part by OSHA, the Occupational Safety and Health Act of 1970 which mandated employers to provide a safe working environment for employees as well as urgent care facilities for both occupational and non-occupational health issues (Burgel, 1993; Cildre, 1997; Russi, Buchta, Swift, Budnick, Hogson & Berube, 2009). An On-Site health care provider builds trust with employees and improves communication which can effectively determine the impact of health conditions on the

organization, diagnoses and recovery due to their familiarity of the employees and workplace facilities (Russi et. al., 2009).

It is in the U.S. where the employer carries the burden of employee health care expenditures and thus, said employers need strategies to contain the rising health care cost trends. Many employers have adopted a self-insured health care model known as Consumer Oriented and Operated Plans (James, 2013). These health plans are owned and operated by the consumer, in this case managed by the employer rather than a commercial insurance provider. One third of all U.S. On-Site health centers have been established since 2000 (Towers Watson/ National Business Group on Health, 2011). According to the report, the primary drivers for implementation of an On-Site clinic in order of importance, were to reduce health care costs, enhance employee productivity, improve access to care, improve integration of health and productivity efforts, improve quality of care, address occupational and safety needs, and offer concierge health services.

Klepper (2013), remarked that worksite primary care clinics have become a popular option for mid-sized to large employers looking to reduce health costs, improve employee population health and productivity. In principle, this approach achieves the financial objectives of the organization by two broad mechanisms. Firstly, the On-Site clinic can provide a variety of medical services at or below local market pricing of clinics within the local health network providing a replacement cost mechanism. These may include medical exams/office visits, prescription medications, diagnostic imaging/ x-rays and blood labs. Klepper (2013) "…*the bigger opportunity is to drive appropriateness, cutting through the current system's perverse incentives, and changing patients' care and cost patterns throughout the care continuum."* (Klepper, 2013). There have been similar models described by other authors. Gawande (2011) which described how one approach by Dr. Rushika Fernandopulle allowed doctors to provide better care to groups of high-cost chronic patients at a lower cost than the local medical network. Other authors have suggested using carrots (incentives) and sticks (disincentives) to motivate employee populations toward more responsible physical and financial health choices (Reeves & Kapp, 2013). Some carrots may be financial incentives or rewards for going to the On-Site clinic for a medical check-up while a stick might be an increase in your insurance contribution costs for not doing so.

Progressive vendors in the On-Site space address a wide range of health care clinical and financial risks for their employer customers by establishing comprehensive primary care health services

combined with a wider range of management approaches that align with the specific needs of the patient and purchaser (employer). These enlightened vendors have an orientation to pursue two goals according to Klepper (2013): (1) Facilitating better care and health for patients and (2) Protecting the financial interests of purchasers (employer & employee patients). Estimates in a study by Price Waterhouse Coopers (PWC, 2008), demonstrated that 54.5% of all healthcare expenditures (+/- $1.5 trillion annually in 2013), added zero value to patient outcomes which Klepper added may be a conservative figure in his estimation.

An argument for the On-Site vendor is that unfortunately, many health plans are looking for ways to exploit the health care pricing system and extract financial gains from more expensive and often unnecessary interventions such as spinal or heart surgeries by leveraging the large employee populations whom they represent (Stergiopoulos & Brown, 2012; Deyo, Mirza, Kreuter, Goodman, & Jarvick, 2010). Other health plans use a subtler strategy according to Klepper (2013). Some examples may include:

- Health plans give the appearance of managing pharmacy costs when in fact they buy a stake in pharmacy benefit management companies that purchase cheap generic drugs allowing the provider to use the egregious margins as a revenue stream.
- Health plans offer the management of high-cost cases as part of their service but do not actually police the expenditures thus encouraging higher costs and spending.
- Health plans promote that they are offering a choice of health care practitioners or facilities but do not analyze the cost benefit of said providers as to patient outcomes and overall cost of services provided thus having no point of reference as to the quality of the service.

These practices all contribute to the high cost of healthcare and the promotion of profit driven practices that do not have the best interest of the payer or patient in mind.

To step away from the profit driven practices of healthcare providers and insurance health plans, some On-Site vendors have created a model outside of the typical fee-for-service reimbursement model to avoid any financial conflicts in care delivery. The provider establishes a fee structure that is based on a per employee, (or member) per month management fee (PEPM or PMPM). The fee generally includes the operational costs for the clinicians, medications, consumables and medical supplies, lab work and utilities. In principle, this approach allows clinicians to deliver the

appropriate care needed and or avoid unnecessary care because of there being no financial incentives or penalties either way. Success outcomes are measured by the overall population health and total cost savings over time. This approach is in stark contrast to common fee for service models where clinicians and healthcare service providers are incentivized to provide and charge for as many products and services as the system will tolerate, regardless if said services are necessary or not. The healthcare delivery process is managed more efficiently and responsibly keeping the patient and employer/clients' interests in mind over the healthcare providers. This approach has the potential of being a market disrupter that could contribute to decreasing the current wasteful healthcare spending in the U.S. (Klepper, 2013).

For this approach to be successful in terms of reducing direct and indirect healthcare costs, barriers to easy access to healthcare services should be eliminated. One-way organizations are removing such barriers to access is to provide the On-Site services for free or at no cost to the employees or their dependents. Under this model employees and their dependents receive medical consults, medications, lab work and in some cases, x-ray exams at no charge. This free access in principle should encourage employees to seek medical care who otherwise may have avoided seeking medical care due to out of pocket costs (Pelletier, 2009; Miller, 2011; Klepper, 2013).

To keep the cost of providing an On-Site primary care facility affordable to the client, some vendors have resorted to using nurse practitioners rather than physicians, claiming that nurses can provide equal or better routine care in some cases, for much less cost (Horrocks, Anderson, & Salisbury, 2002; Burgel, 2012). This trend is commonly found among most of the On-Site primary care provider vendors today in the U.S. Physicians are still maintained for more complex and costly medical cases. As such, many vendors have a hybrid approach of using nurse practitioners for most routine medical visits with physician oversite for the more complex cases.

Another advantage to the On-Site approach is the time clinicians spend with patients. The average network physician has a case load typically of more than 2500 patients per doctor which translates to an average visit time of 12 minutes. According to research, this physician overload has fueled the referral to and use of costlier and often unnecessary specialty consults, diagnostics and procedures which drives up costs and increases risks for patients (Barnett et. al., 2012). Under the PMPM model, the per physician case load is substantially lower, allowing physicians more time to fully evaluate and properly assess patients thus decreasing the more costly and unnecessary

specialty referrals. As such, better outcomes are achieved with decreased exposure to risk and lower cost per patient.

In an interview with a specialist in healthcare analytics and information technology infrastructures (Nguyen, 2016) the advent of electronic health records (EHR), has contributed to the efficiency of health care delivery by reducing waste and duplication in the healthcare system thus reducing expenditures by billions of dollars each year in the United States. Such tools allow for the management of large population health systems by making available and sharing patient information between healthcare professionals, clinics and hospitals. This streamlines processes and allows clinicians to have access to and transfer of essential patient information such as health risk factors, biometric profile data, medication claims and pharmaceutical records, surgical records, utilization of disease management services etc. With such an integrated and extensive patient information system, patients can be put into low, medium or high-risk categories thus helping such informed physicians to make appropriate diagnosis and treatment plans for their patients as well as reducing the risks and costs associated with inappropriate diagnoses and unnecessary interventions. Also, gaps in care can be identified thus assisting physicians in making appropriate recommendations. EHRs have become part of the On-Site primary care clinics procedures and processes thus adding value to the service and reducing costs for the general employee population. Nguyen stated that some systems allow for direct access to data by the patient via web-based portals which helps the patient through knowledge and awareness to be more involved and play an active role in their own health care continuum.

2.3 Productivity:

2.3.1 Productivity/performance measures:

What is meant by employee productivity and performance in the context of this study? Productivity is the subjects perceived ability to perform daily work tasks well, on time, without interruption, interaction with colleagues, decision making, energy levels and time management (Lerner, 2002). It should be noted that Dr. Debra Lerner is the developer of the Work Limitations Questionnaire (WLQ) and was instrumental in assisting the author in obtaining and ultimately using the tool for this study. The WLQ was chosen because it reliably measures productivity on several physical and psychometric levels. This study being a self-completing questionnaire, it

must rely on the subjective response of the participant being asked the question. According to Litmos, an on-line corporate training platform, employee performance is defined as whether a person executes their job duties and responsibilities well. Performance is a critical factor in organizational success (Litmos, 2017). How does one measure performance? The measure of performance is different for each organization. The challenge is to find which specific measures will enable each organization to improve business outcomes. This type of measurement unit is commonly referred to as KPIs or Key Performance Indicators which are the foundation of performance measurement and target setting (Info-Entrepreneurs, 2017). There are many KPIs which may include measuring one or more of the following; reaching objectives or targets, financial performance, customer satisfaction, or benchmarking against other companies, just to name a few. Such specific measurements are beyond the scope of this thesis.

Lebas and Euske (2007) define performance as "doing today what will lead to measured value outcomes tomorrow." Each of the organizations under this study will have their own set of KPIs, thus, self-reporting as to each participants perception of their personal performance and how their MSD problem impacted this perception, will be our measurement.

2.3.2 Presenteeism:

Presenteeism is not yet a widely researched concept for the management or organizational behavior sciences and has only recently been studied (early 1990's) when compared to absenteeism (Johns, 2010). The concept is based on the lost productivity associated with coming to work sick or being present at work but limited in some aspects of job performance by health problems (GCC, 2016; Lui, Andres, & Johnston, 2018). There may be many motives behind presenteeism such as large workloads, long hours expected by the employer, employees coming to work because they cannot afford to miss work, workaholics or simply their love and devotion to the job (Robinson, 2001; Simpson, 1998; Johns, 2010). Some employees may fear that job advancement or future career prospects may be damaged if they miss workdays due to sickness (Johns, 2010). There are some differing opinions and a lack of agreement by researchers when attempting to show construct validity (Simpson, 1998; Johns, 2010; Aronson et al., 2000). Simpson claimed that presenteeism is "the tendency to stay at work beyond the time needed for effective performance on the job" (Simpson, 1998). Other researchers define presenteeism as employees who go to work even when they feel unhealthy (Lui, Andres, & Johnston, 2018; Lahaus & Habermann, 2019). Presenteeism

is also referred to in the literature as presenteeism sickness and in addition to absenteeism, has been a concern for the European Labour Force (Bockerman & Laukkanen, 2010). Bockerman and Laukkanen stated:

"The presence of the 3 days' rule at the workplace, i.e. 3 days' paid sickness absence without a sickness certificate, decreases sickness presenteeism by 8%. The presence of the efficiency rule at the workplace, i.e. 'in tough situations efficiency rules out everything else', increases the prevalence of sickness presenteeism by 8%. Therefore, focusing only on efficiency increases workers' sickness behaviour in the form of presenteeism" (Bockerman & Laukkanen, 2010).

Productivity losses are directly associated with presenteeism. Dr. Olivia Sacket, a Data Scientist for Virgin Pulse, reported that employees, on average took about four sick days off each year, but when employees reported how many days they lost on the job, the number increased to 57.2 days per year per employee (GCC, 2016). That is almost 12 working weeks, or one quarter of the entire year that employers are paying employees to be present physically but not mentally. This corresponds to a person working at 75 percent of their maximum productivity level (Smith, 2016).

Researchers have attempted to measure and estimate the lost productivity costs associated with presenteeism (Johns, 2010). A large study performed in the U.S. demonstrated substantial financial losses associated with presenteeism (Goetzel et al., 2004). The authors concluded one fifth to three fifths of costs and expenses faced by employers could be attributed to presenteeism (Goetzel et al., 2004). Extensive studies have been done to determine the impact that certain health conditions such as chronic pain, arthritis, diabetes, allergies and mental health disorders had on productivity (Burton et al., 2001; Schultz & Eddington, 2007). Interestingly, Schultz and Edington noted that chronic pain had to be studied more thoroughly to better understand its effects on productivity (Schultz & Eddington, 2007). A review of literature on the topic of presenteeism showed that, to date, neither a uniform definition nor consistent methods for measuring have been employed in any research on presenteeism (Lahaus & Habermann, 2019).

Researchers have used many methods to measure presenteeism in terms of how often employees attend work while unhealthy. Aronsson, in his study, asked subjects to what extent over the past year they went to work when they felt they probably should have taken the day off (Aronsson, 2000). Respondents could choose from never, once, between two and five times or more than five times. Similar approaches have been done by other researchers using "spells of one day

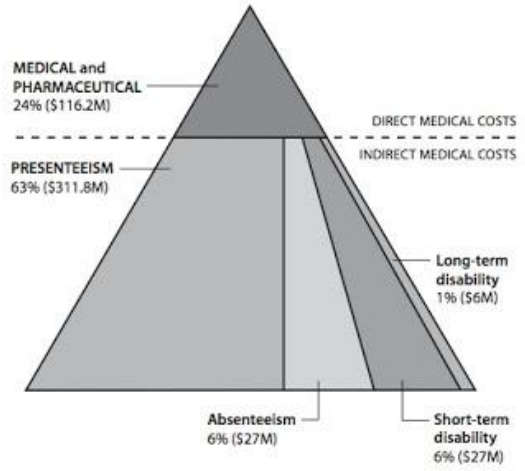
presenteeism, spells of 2-4-day presenteeism, and spells of 5 day or more presenteeism" (Munir, Yarker, Haslam, Long, Leka, Griffeths, & Cox, 2007).

The effects of poor health on productivity have also been measured. There are three widely used tools to achieve this task. The Work Limitations Questionnaire (WLQ) is one of the most frequently used for this task (Lerner, Amick, Rogers, Malspeis, Bungay, & Cynn, 2001). The tool consists of 25 items which measures the extent to which subjects can perform physical, mental, interpersonal and output demands on the job over the past two weeks. Another tool is known as the Stanford Presenteeism Scale which measures the subject's ability to concentrate and perform work tasks despite their health condition (Koopman, Pelletier, Murray, Sharda, Berger, & Turpin, 2002). A third tool which is widely used is known as the World Health Organization Health and Work Performance Questionnaire (WHO-HPQ) (Kessler, Barber, Beck, Berglund, Clearly, McKenas, Pronk, Simon, Stang, Uston & Wang, 2003).

The three tools are self-reported questionnaires which seek to elicit the employees' perceptions of their on-the-job performance in relation to their current health condition. The WLQ and HPQ have become the most popular instruments in the study of presenteeism (Schultz, 2007). For this reason, the WLQ was chosen as the tool for this study to measure the perceived impact of MSD on the subjects' work performance and productivity.

The practical implications of researching presenteeism is that such information can be used to properly educate managers to make informed and effective decisions when implementing health strategies (Schultz, 2007). Schultz and Eddington also suggested that employers need to consider the health of workers who are low risk along with those who have high-risk health conditions, risk meaning, potentially life threatening (Schultz & Eddington, 2007).

Figure 4 below provides a visual example of the relative cost impact of presenteeism taken from a study done for Bank One & J.P. Morgan Chase & Co., written by Hemp, 2004. The image was used in a Harvard Business Review article on Presenteeism (Hemp, 2004). The graphic demonstrates relative costs of presenteeism compared with medical costs, absenteeism costs and disability costs.



(Hemp, 2004) Bank One/J.P. Morgan Chase & Co. Study.

Figure 4 Cost of Poor Health to Employers.

According to a report by the Global Corporate Challenge (GCC), on average, employees cost businesses the equivalent of three months per year in lost productivity, the cost of which adds up to over 10 times higher than absenteeism (GCC, 2016). Absenteeism has been estimated to cost U.S. employers around $150 billion USD per year, but employees who came to work and were not fully productive, cost an estimated $1,500 billion per year (GCC, 2016; Smith, 2016).

2.3.3 Decision Making:

What is decision making in the context of work for this study? This study relies on the subject's own perception of their decision-making ability. Decision making is the procedure of reducing the gap between the existing situation and the desired situation through solving problems and making use of opportunities (Saroj, 2014). A typical decision measurement helps organizations in setting targets thus providing feedback to managers on the progress made toward the targeted objectives (Nura & Osman, 2012). According to Mankins and Steele (2006), they believe that managers should spend less time on planning and devote more time toward making and measuring decisions. This opinion supports using decision making ability as a useful measurement for this study. There are many frameworks and models for the decision-making process in business. Problem solving is another term used interchangeably in decision-making research, particularly in European psychological research on Complex Problem Solving (CPS) primarily concerned with problem solving behavior in artificially generated, mostly computerized, complex systems (Frensch & Funke, 1995).

Studies have suggested that decision making behaviors are different cross-culturally and exist across entire societies. As an example, one researcher has found that American, Japanese, and Chinese business leaders each exhibit a distinctive national style of decision-making (Martinsons, 2006). A person's decision-making process depends to a substantial degree on their cognitive style (Myers, Kerby & Myers, 1998). Meyers developed the Myers-Briggs Type Indicator (MBTI) based on four bi-polar dimensions, the terminal points of which include: thinking and feeling; extroversion and introversion; judgment and perception; and sensing and intuition (Myers et al., 1998). Briggs claimed that a person's decision-making style correlates well with how they score on these dimensions, but some researchers claim that the MBTI lacks reliability and validity and is poorly constructed and some go as far as to refer to it as nothing more than an elaborate fortune cookie (Pittenger, 2005; Hogan, 2007).

We could go further into the topic of decision making but it is not the objective of this work to do an analysis of this extent but rather to study the impact that MSDs have on the subject's perception of their decision-making ability.

2.3.4 Energy Levels:

Schwarts and McCarthy (2007) in a Harvard Business Review article titled; "*Manage Your Energy, Not Your Time",* they spoke about the impact of managing one's energy throughout the day to effectively impact one's performance. Most large organizations do not invest in or help employees to build their energy sustainability or work capacity. Most resources are focused on developing employee's skills, knowledge, and competence (Schwarts and McCarthy, 2007). Their article spoke about the importance of creating healthy habits and rituals throughout one's day such as getting more sleep, making healthy food choices, getting regular exercise etc., and how such rituals could literally impact the KPIs of an organization. They dubbed their experiment the "Energy Project" which took key elements from athletic training principles and applied them to the work environment. Not only did the project result in greater work performance, sixty-eight percent of the participants in one study reported that it had a positive impact on their relationships with clients and customers. Indeed, making energy and important and relevant measurement for this study.

Lack of energy can be a sign of Fatigue. Fatigue is a complex multidimensional symptom. The symptoms of fatigue have been defined as a lack of energy, exhaustion or tiredness distinct from

sleepiness, sadness, or weakness (Krupp, Alvarez, LaRoccca, & Scheinberg, 1988; Lerdal, 1998; Lerdal, 2013). Fatigue negatively impacts one's quality of life and is a common symptom among adults living with chronic illness (Voss, 2005; Hofman, Ryan, Figueroa-Moseley, Jean-Pierre, & Morrow, 2007; LaVoy, Fagundes, & Dantzer, 2016).

Perceived energy has been defined as: "the individuals' potential to perform physical and mental activity" (Lerdal, 1998). Lerdal (2013) did a study entitled; "Lee Fatigue and Energy Scales: Exploring aspects of validity in a sample of women with HIV using an application of Rasch model. The Rasch measurement model is used for validation when measuring human performance and experience (Tesio, 2003). Individuals present with variables such as pain, fatigue, depression, which cannot be measured directly, thus are referred to as "latent" variables. In 1960, Georg Rasch developed a statistical model which complied with fundamental assumptions made in measurements in physical sciences thus allowing for the transformation of cumulative raw scores into linear continuous measures of ability and difficulty. The Rasch modelling is frequently applied to rehabilitation medicine. More recent scales with unprecedented metric validity (including internal consistency and reliability) can be constructed according to each study (Tesio, 2003). The Rasch modelling allows for the improvement or rejection of existing scales based on a comprehensive theoretical basis.

Using the Rasch modelling approach, the Lee Fatigue and Energy Scales were tested for, unidimensionality, internal scale validity, and uniform differential item functioning in relation to morning and evening scores/ratings. The study confirmed that both the Fatigue and Energy Scales verified consistent evidence of internal scale validity and unidimensionality. The concepts of fatigue and energy were inversely related.

2.3.5 Interaction with Colleagues:

It could be postulated that healthy relationships and interaction among work colleagues have a positive effect on an organization's effectiveness as a business and vice versa, poor relationships have a negative effect. The author believes this is a variable which is significant for business research, thus explored tools and methods of evaluating and measuring relationships to validate this as a variable to be used for this research.

There has been increased interest in the understanding of the nature and influence of social relationships for behavioral scientists and behavioral economists and thus an increased need for

reliable tools to measure social relationships (Gachter, Starmer, & Tufano, 2015). How then, does one effectively measure a subjective judgement such as the perceived closeness of a relationship? One such tool is the "Inclusion of the Other in the Self' Scale" (IOS), (Aron A., Aron E., & Smollen, 1992). It is described by Gachter (2015), as a highly portable, intuitive, easy to understand and quick (less than 1 minute to administer). It is a simple pictorial tool which measures one's degree of closeness on a scale of 1 to 7 and is hypothesized to tap people's sense of being interconnected with another (Aron, et al., 1992). Gachter (2015) concluded that the IOS Scale was a highly reliable measure of the subjective closeness of relationships thus psychologically meaningful. Working relationships are often non-close relationships such as acquaintances and require a different tool for measurement.

The WLQ used for this study to tests interpersonal relationships with work colleagues in one section of the questionnaire, therefor covering this concept in a more general way, being more appropriate for the productivity measurements for this research.

2.3.6 Hypotheses on Productivity

From What we have just said two hypotheses emerge:

Hypothesis 1:

MSDs increase Productivity Losses (DMAA, 2009; Hoy et al., 2014; CIPD, 2016; Fit for Work, 2016; Klepper, 2017; Middlesworth, 2017; Folger, 2018)

Hypothesis 2:

On-Site MSD intervention Reduces Productivity Losses. (Norman R. & Wells R, 1998; Lahiri, Gold, & Levenstein, 2005; LaPenna, 2010; Klepper, 2017; Middlesworth, 2017; Folger, 2018)

2.4 Absenteeism:

2.4.1 Definition of Absenteeism:

What is absenteeism in the workplace? There is no standard or universal definition for workplace absenteeism, therefore, there is no consistent definition in the workplace research of individual institutions (The Australasian Faculty of Occupational Medicine, 1999). According to the Marriam-Webster dictionary it is defined as "chronic absence (as from work or school); also: the rate of such absence" (Merriam-Webster, 2017). According to the Business Dictionary (BD,

2017), absenteeism in the context of employees is defined as; "Voluntary non- attendance at work, without valid reason. Absenteeism means either habitual evasion of work, or willful absence as in a strike action. It does not include involuntary or occasional absence due to valid causes, or reasons beyond one's control, such as accidents or sickness". In general, absenteeism is unplanned absence from work (The Australasian Faculty of Occupational Medicine, 1999). In 2013, a UK report estimated that the average worker had 7.6 absent days per year (CIPD, 2017).

There are two types of absenteeism, planned and unplanned. Planned absenteeism may include sabbaticals, early retirement, and scheduled time off for holidays or scheduled events. Such planned absences cause little disruption to the workplace (The Australasian Faculty of Occupational Medicine, 1999). Unplanned absence is defined as absence that is not predictable, such as, sick days, injury time off, and missed work without permission (The Australasian Faculty of Occupational Medicine, 1999).

For the purposes of this study, absenteeism is defined as hours or days missed from productive work because of the subjects MSD condition resulting in disability, intervention/treatments, consults and diagnostics.

2.4.2 Measuring Absenteeism:

Measurement methods for absenteeism are not standardized nor are the wide range of variables for defining absenteeism (Genowska, Fryc, Pinkas, Jamilkowski, Szafraniek, Szpak & Bojar, 2017). The inherent challenges in studying a complex behavior with negative connotations has stimulated methodological diversity (Johns, 2003). Also, due to a wide variety of academic and professional disciplines showing interest in absenteeism has lead to the expansion of methodological diversity (Johns, 2003). One such method used in human resource management for measuring worker absenteeism is the Bradford Formula, also known as the Bradford Factor (Bradford Factor, 2006). The tool was developed by the Bradford University School of Management in the 1980's. The theory is that short, frequent and or unplanned absences are more disruptive and costlier to organizations than long term absences. It was originally used for the overall management and study of absenteeism within organizations and is used to calculate an "attendance score" (CIPD, 2007). The use of the Bradford Formula often led to heated debate as the scores were calculated based on instances of absence over a 52-week period, but lacking context for justification (Bradford Factor, 2006).

Employers often excuse absenteeism caused for medical reasons if the employee provides medical justification through documentation (Genowska, et al., 2017). Even though the research shows that companies with successful health and productivity programs have superior business outcomes and higher returns, there are no standardized validated methods to measure the true costs associated with lost work time (DMAA, 2009; Mattke, Balakrishnan, Bergamo, & Newberry, 2007, Towers Watson, 2009/2010).

2.4.3 Causes of Absenteeism:

Research on medical-based absenteeism finds links to a variety of medical reasons such as, mental and behavior disorders, neoplasms and diseases of the digestive or genitourinary systems. This excludes pregnancy and childbirth (Genowska, et al., 2017). Much of the research in absenteeism made a correlation between absenteeism and other variables such as performance, job satisfaction, organizational commitment, and age (Bycio, 1992; Farell & Stamm, 1988; Hackett, 1990; Martocchio & Harrison, 1993; Spector, 1986). Early studies focused on the relationship between 3 attitudes; job satisfaction, job involvement, and supervisory satisfaction (Breaugh, 1981). A longitudinal study evaluated prior two-year absenteeism rates of a group of 119 research scientists as a predictor of future absenteeism, showing that, prior absenteeism was a better predictor than the 3 work attitudes (Breaugh, 1981).

Employees and managers seldom, officially report or record absence from work for medical consults and most supervisors have not received any guidance or training in managing absenteeism (Yorges, 2016). In that light, sickness absence is caused by a variety of health challenges. Most absence is caused by genuine reasons that are likely to resolve within seven days, known as short term absence (Fit for Work, 2016). Such reasons may include; minor illness, stress, musculoskeletal disorders, recurring medical conditions and back pain (Fit for Work, 2016). Most long-term absence is caused by acute medical conditions, musculoskeletal injuries, stress, mental ill health and back pain (Fit for Work, 2016). Though most illness or injury is not necessarily caused by work, a U.K. study in 2007/08, showed an estimated 2.1 million people in the U.K. were suffering from an illness caused while working or made worse by their work (Fit for Work, 2016). Back pain, which has many work-related causes, is the principal reported reason for work related absence in the U.K. Work-related absence in the U.K., in order of frequency include: MSDs, upper limb disorders, occupational asthma, occupational dermatitis, work-related noise, and hearing loss

(Fit For Work, 2016). According to study among 1,000 business managers, by AXA PPP Healthcare, a large U.K. based insurance company, the most common excuses by employees were: flu: 41.6%; back pain: 38.5%; injury caused by accident: 38.2%; stress: 34.5%; elective surgery: 35.2%; depression: 34.5%; anxiety: 25.4%; common cold: 23.8%; migraine: 21.7%; none of the above: 7.7%. (Sheffield, 2015; Dailypay, 2017). According to the report, managers are more likely to accept back pain than depression as a reason to stay home from work (Sheffield, 2015; Dailypay, 2017).

In addition to illness and injuries, other causes of absenteeism may include; bullying and harassment, burnout, stress, low morale, childcare and eldercare, depression, disengagement and job hunting (Folger, 2018). Another form of absenteeism is "Partial Shifts" which is, arriving late, leaving early and taking longer breaks than allowed and can affect productivity and workplace morale (Folger, 2018). Mental health issues and work-related stress are also responsible for work-absence. Most of the causes of stress and mental health related sickness absence include concerns about; workload demands, job security, work relationships and work-life balance (Fit for Work, 2018; SCMH, 2018).

2.4.4 Cost of Absenteeism:

The research also shows that medical-related absenteeism leads to over one trillion dollars per year in lost productivity globally. Such costs are above and beyond medical spending (Loeppke, R., 2009; DMAA, 2009). Health related absenteeism is estimated to cost US employers more than $260 billion each year and may cost some companies more than direct medical costs (Davis et al., 2005; Mattke et al., 2007). In 2013, the UK (CIPD, 2017) estimated that the workers were absent an average of 7.6 days per year which cost employers £595 per employee, per year. The average employee in the U.K. takes seven days off sick each year, 40 percent of which is related to mental health problems and adds up to £8.4 billion a year in sickness absence in mental health costs (SCMH, 2018). In the U.S., it is estimated that unscheduled work-absence can cost as much as $3,600 per year for hourly workers and over $2,500 per year for salaried employees (Mitrefinch, 2018). It is estimated that 1 in every 10 employees is absent on any given day, at a cost to employers from 3.2 to 7.5 percent of payroll annually (Mitrefinch, 2018). On average, a shift worker in the U.S. costs a company roughly $2,660 in excess absenteeism costs each year which translates to roughly $1.3 million in direct absenteeism costs for a company with 500 shift workers

(Circadian, 2014). Fatigued workers have been shown to cost companies an additional $405 per year in health-related absenteeism which translates to $202,500 per year for a company of 500 employees and $156.5 billion (adjusted for 2014 inflation) annually in the U.S. (Ricci, Chee, Lorandeau & Berger, 2007; Circadian, 2014). Fatigued workers cost a company nearly 4 times more than non-fatigued counterparts in absenteeism and presenteeism (Ricci, Chee, Lorandeau & Berger, 2007).

2.4.5 Bed and Lost Work Days due to MSDs:

MSDs result in hundreds of millions of days spent in bed or missed work every year (NIHS, 2013). In 2012, 57.5 million adults, aged 18 or older, reported spending an average of 9 days in bed, amounting to a total of 528 million days due to MSDs or injuries (NIHS, 2013). The most common injuries for which persons reported days in bed were back or neck pain, together, accounted for over 70% of self-reported bed days for all medical conditions in 2012 (NIHS, 2013). *Figure 5* below demonstrates the proportion of self-reported bed days and lost workdays caused by medical issues with back and neck pain and arthritic conditions, all MSD issues; as the top causes.

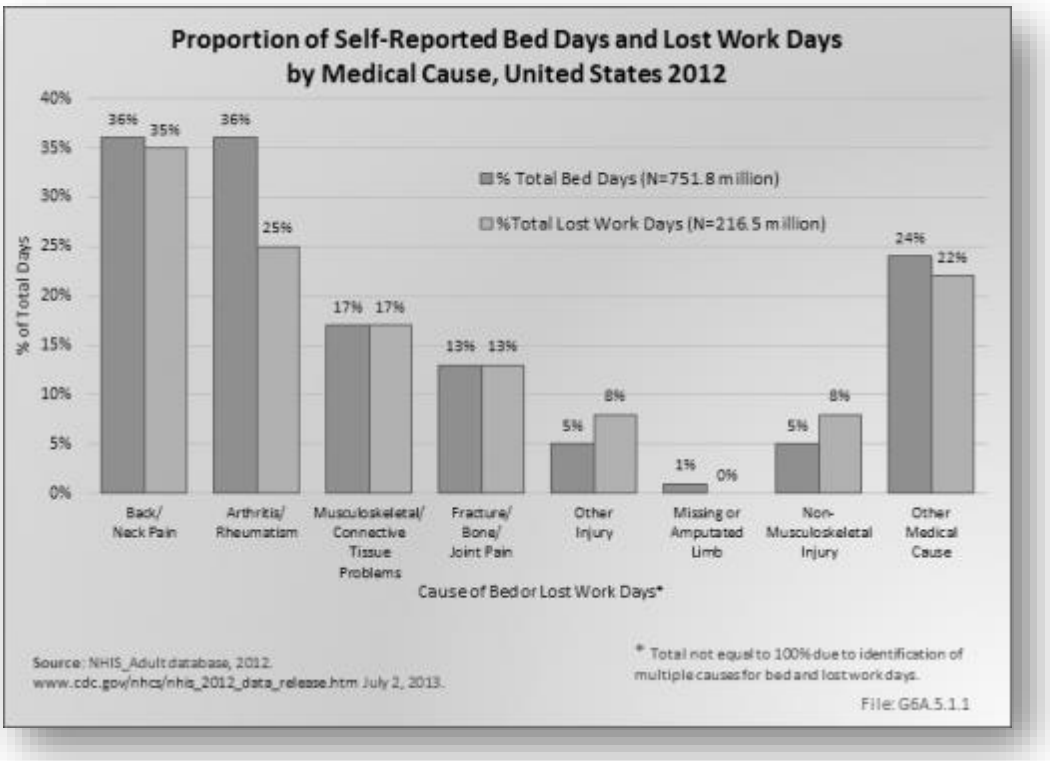


Figure 5 Proportion of Self-Reported Bed Days and Lost Work Days

- **1.** A bed day is defined as one-half or more days in bed due to injury or illness in past 12 months, excluding hospitalization.
- **2.** A missed work day is defined as absence from work due to illness or injury in the past 12 months, excluding maternity or family leave.

2.4.6 Hypotheses on Absenteeism:

From What we have just said two hypotheses emerge:

Hypothesis 3:

On-Site MSD clinics will decrease MSD related Absenteeism (Abásolo et. al., 2005; LaPenna A.M., 2010; Sharan, Deepak, 2012; Klepper, 2017; Folger, 2018; Middlesworth, 2017)

Hypothesis 4:

On-Site MSD clinics will decrease MSD related Absenteeism Costs (Arnetz, Sjögren, Rydéhn, & Meisel, 2003; LaPenna A.M., 2010; Klepper, 2017; Folger, 2018; Middlesworth, 2017)

3.0 THEORY AND PRACTICE OF WORKPLACE WELLNESS.

3.1 Origins: Work Place Wellness Programs (WPWPs).

Work Place Wellness Programs (WPWPs) originated in the United States in the 1960's and 70's (Reardon, 1998) and were created for providing better working conditions, healthcare cost containment, reduction of absenteeism, increasing productivity, attracting and retaining good employees, encouraging morale and promoting safety (Gordon 1985, Reardon 1998, Baicker, 2010). Several large corporations such as Ford, GE, Motorola, U.S. Steel, Digital Equipment, Westinghouse, have adopted this philosophy as a business practice (Gordon, 1984). In 1979, Johnson and Johnson created a prototype to the modern WPWP known as their *Live for Life Program* (Penkak, 1991). According to Penkak, (1991), the study was designed to identify high risk habits and behaviors using a health risk assessment (HRA) as well as physical exams to determine body fat measurements. The program provided support and education on nutrition, weight control and stress management. Later programs were influenced the U.S. federal government's "Healthy People 2000" initiatives (USPHS, 1991, 1992) that focused on smoking cessation, nutrition and weight loss as preventative measures against heart disease as a cost saving strategy.

Insurance in the United States was employer based (Baicker, 2010) thus the financial burden of health care costs fell primarily on the employer. According to Archer (2012) insurance premiums in the U.S. increased 114 percent between 2000 and 2010. During the same period worker's premiums increased 147 percent (Keiser, 2012). It has been estimated that the cumulative or indirect cost of chronic diseases was far greater than the cost of treating chronic diseases which amounted to $4.2 trillion in treatment costs and lost economic output (DeVol, 2007).

With the intention of reducing health care costs, WPWPs focused on diabetes, heart disease and chronic pulmonary disease caused by inactivity, poor eating habits, alcohol consumption and smoking (CDC 2010, Baicker 2010, Arnold 2009). Employees with chronic illness had health care costs over four times greater than healthy employees (PWC, 2010).

The literature demonstrated that the increased need for cost containment created business opportunities. The evidence of positive outcomes justified investing in programs, staff and facilities. (Eakin, 2001). DeJoy (2003) suggested that workplace health promotion should be a part of a core business strategy and operations management. DeJoy (2003) said that WPWPs were an effective single strategy that aimed to maximize employee health and productivity. Leurent (Leurent, Reddy, Voute, & Yach, 2008) commented on statements from the 2008 World Economic Forum, that WPWPs had been successful at improving worker's health and productivity, increased employee loyalty and decreased health care costs.

From the business management perspective, an American researcher (Fabius, 2013) tested the hypothesis that a company's stock market performance could be influenced by comprehensive and well implemented WPWPs aimed at reducing health and safety risks. By studying a wide range of companies recognized for having award winning health and safety programs, he concluded that such companies had a competitive advantage in the marketplace which resulted in greater value for their investors than companies that did not have such programs.

3.2 What did Workplace wellness programs focus on and why?

The research indicated that most insurance in the United States was employer based (Baicker, 2010). The burden of health care costs fell primarily on the employer, so it was in the best interest of the employer to contain the rising costs of health care.

Chronic Diseases as Targets for WPWPs:

WPWPs focused on behaviors that lead to chronic diseases identified by the Center for Disease Control and Prevention (CDC, 2010). The CDC identified diabetes, heart disease and chronic pulmonary disease caused by inactivity, poor eating habits, alcohol consumption and smoking. They also identified arthritis and musculoskeletal disorders, but those areas typically did not appear in wellness programs.

Most workplace wellness programs began with a health risk assessment (HRA) a self-reporting questionnaire to get a base line on the health and habits of the employees (Baicker, 2010).

Chronic diseases were once thought of as an issue for the elderly. The number of working aged adults with chronic diseases has reached nearly 58 million in the past ten years, a nearly 25%

increase (Hoffman, 2008). This shift of a younger working population with chronic diseases has put a tremendous burden on companies due to absenteeism, presenteeism and the resulting lost productivity. One study by Price Waterhouse Coopers demonstrated that employees with chronic illness have health care costs over four times greater than healthy employees (PWC, 2010). It has been estimated that the cumulative or indirect cost of chronic diseases (i.e. absenteeism, presenteeism) was far greater than the cost of treating chronic diseases. This amounts to 4.2 trillion in treatment costs and lost economic output according to research (DeVol, 2007).

What services did workplace wellness programs offer employees?

The use of workplace wellness programs has been on the rise in the United States according to the International Foundation of Employee Benefit Plans (Professional Safety, 2012). The study showed that companies focused their workplace wellness initiatives and resources on health fairs, health screenings and flu shots. The survey, "Wellness Programs and Value Based Health Care", showed 60% of employers have had workplace wellness programs since 2008 with an additional 24% since 2010.

The literature review showed a trend that workplace wellness programs focused on the same targets. According to the article by Arnold (2009) the targets for on line programs included smoking-cessation, nutrition, exercise, weight loss and stress management. Some companies also offered an employee fitness center with instructors and On-Site meetings with wellness coaches according to Arnold (2009). Currently, corporate wellness programs perform services such as cholesterol, diabetes and blood pressure screenings known as Biometric Screenings, diet coaching and encouraging exercise.

3.3 The Business side of WPWPs: The Employers perspective:

3.3.1 The Cost of WPWP Implementation:

In an interview with Dee Edington at the Michigan corporate Health Management conference, a company should invest between $300 and $400 per employee if they expected a decent ROI. Edington went on to say: "medical care is expensive, wellness care is free" (Hall, 2011). Goetzel recommended investing $150 per year per employee for an average return of $450 per year per employee (Hall, 2011).

The author could not find supporting data for the U.K. market concerning investment recommendations for workplace wellness programs. There were a large variety of wellness program offerings ranging from nutritional counseling, psychosocial or work life balance programs, lifting techniques and physiotherapy services in the manufacturing, financial and government sectors. There was very limited information as to the cost for services.

3.3.2 The ROI of WPWP Implementation:

As stated from the research earlier, for programs to be effective, there needed to be employee engagement. Employee participation rates on average in 2009 were 42 percent and in 2011, 49 percent. Smaller companies have a higher engagement rate than larger companies or 61 percent versus 45 percent (Optum, 2012).

Abshire (2013) cited a study entitled: "Closing the Engagement Gap" (Towers Watson, 2007-2008) which showed an impressive 19 percent operating income increase and 28 percent growth in earnings per share. The study also showed the inverse results for unengaged employees that led to a drop of operational income of 32 percent and an earnings per share decrease of 11 percent. In an interview with Eileen Wilcox, director of human resources for Blue Cross Blue Shield of Louisiana, the company had seen a decrease in employee turnover of 5 percent as well as a significant decrease in long-term disability and workers' compensation expenses using primarily on-line tools (Arnold, 2009).

A met analysis of the research data has shown a decrease in medical costs of $3.27 for every dollar spent as well as a decrease in absenteeism losses of $2.73 for every dollar spent (Baicker, 2010) on WPWPs. A Citibank Health Management study reported a return on investment of $4.50 for every dollar spent (Ozminkowski, 1999). Studies of other programs by Johnson and Johnson (1986 study), and Bank of America (1992 study) showed very similar return on investment results (Baicker, 2010).

Scott (2011) suggested an integrated approach to health and wellness care in the workplace for improved outcomes and return on investment. For example, if an employee was on leave due to an occupational injury, they could use that time to be evaluated for non-occupational health challenges such as diabetes and benefit from educational opportunities.

A met-analyses of research-based wellness programs focused on the reduction of cardiovascular risks reported a $6 savings for every dollar invested in a 12-month pre and post implementation program, with a range of $3 to $15 return after several years for every dollar invested (Arena, Guazzi, Briggs, Cahalin, Myers, Kaminski, Forman, Cipriano, Borghi-Silva, Babu & Lavie, 2013). Arena, et al., (2013) implied that even in the face of evidence that there was a return on investment for wellness initiatives, there was a wide degree of variability among ROI results due to the wide variability of wellness delivery models presented in each case.

Most of the literature and hence the citations in this paper about workplace wellness came from studies done in the United States. The U.S. had nearly 50 years' experience in the workplace wellness arena. This was due to the earlier stated fact that in the United States, the financial burden of health care fell squarely on the shoulders of the employer. With the ever-increasing cost of health care combined with an ever-younger workforce suffering from chronic diseases, U.S. corporations needed solutions to this crisis. The CDC (Centers for Disease Control) reported that the cost of treating chronic diseases in the United States accounted for 75 percent of the U.S.'s national healthcare expenditures (CDC, 2010).

In the U.K. as in Portugal, the cost of healthcare was found to be primarily on the shoulders of the taxpayer and distributed by the NHS, therefore, U.K. corporations were less concerned about the burden of healthcare costs. Workplace wellness in the U.K. fell in two primary categories. Corporations and Government. Corporations were investing in wellness programs for increased shareholder value or profits according to Boyes (2000) by containing the costs associated with lost productivity due to missed work rather than both lost productivity and healthcare costs managed by their U.S. counterparts. The U.K.'s Health and Safety Commission focused on prevention by reducing risks to employee health in workplace activities which holds true for all EU member states, including Portugal. Risk assessments and guidelines based on knowledge and understanding of health and safety were their primary aims (Boyes, 2000). In an interview of Health and Safety Commission Chair Bill Callaghan by Wilf Altman, Callaghan stated, "Good Health is Good Business" (Altman, 2000). Callaghan went on to say that over two million people in the U.K. suffer from work related illness that amounted to billions of pounds in health care costs to society. Musculoskeletal and particularly lower back pain were reported as the most common work- related illness said Callaghan (Altman, 2000).

The research showed that both U.S. and U.K. corporations have dealt with the same major problem, indirect medical costs such as absenteeism and presenteeism. Indirect medical costs were the real cost driver behind workplace wellness solutions in both nations (Jacob, 2014). Chris Nicholson, COO of Humana Wellness, a large insurance provider in the U.S., stated that most companies overlooked cost cutting opportunities when they focused only on direct medical costs such as treatment or pharmaceuticals. Indirect medical costs such as absenteeism or presenteeism (lost productivity) accounted for nearly 70 percent of health care costs (Jacob, 2014). Nicholson gave an example of their study that indirect medical costs compared to direct medical costs outweighed them by a ratio of 10:1 for headaches. An average company of 5000 employees which had to deal with the cost of type II diabetes, a preventable disease, spent $1.2 million of which $900,000 were indirect medical costs (Jacob, 2014).

In a lecture by Bob Merberg (2014), he stated that his experience was that traditional corporate wellness programs did not demonstrate a direct ROI or reduction in health care costs. His focus and theory were that employees who felt cared about by their employer tended to perform better at work and stayed longer with that employer. Merberg's opinion was that the United States was the only country where health care cost containment was the primary purpose of implementing a wellness program. In his opinion, Europe and Asia's primary purpose of wellness programs was to keep employees healthy and working and to boost morale. Merberg quoted a study from the Journal of Occupational & Environmental Medicine that stated companies with effective wellness programs demonstrated: 20% more revenue per employee, 16.1% higher market value and 57% higher shareholder returns (Fabius, 2013). Merberg's objective was to identify ways to get vendors and other stakeholders to embrace non-ROI metrics as valid and achievable outcomes.

3.4 The Business Strategy of WPWPs:

A report stated that there was much more at stake concerning wellness programs due to ever higher health care costs putting financial pressure on corporations (Ryan, Chapman, & Rink, 2008). Ryan (2008) suggested that the wellness program had to be aligned with the priorities and objective of the company as well as having capitalized on the organization's values.

The National Business Group on Health estimated that the demand for workplace wellness programs would increase by 18 percent over the next five years (Archer, 2012). According to

Archer (2012) insurance premiums in the U.S. increased 114 percent between 2000 and 2010. During the same period workers premiums increased 147 percent (Keiser, 2012) an additional 78% between 2012 and 2018 (KFF, 2019). The literature demonstrated that the increased need for cost containment created business opportunities. The evidence of positive outcomes justified investing in programs, staff and facilities (Eakin, 2001). DeJoy (2003) suggested that workplace health promotion should be a part of a core business strategy and operations management, DeJoy (2003) said that workplace wellness was an effective single strategy that aimed to maximize employee health and productivity. Goetzel (2007) stated that in today's business environment, the competitive edge went to the organization that made the best use of their human resources. Leurent, et al. (2008) commented on statements from the 2008 World Economic Forum, that workplace wellness programs had been successful at improving workers' health and productivity, increased employee loyalty and decreased health care costs. It has become an accepted fact within the NHS trust system that socially responsible organizations who embraced workplace wellness were profitable. A healthier, fit and happier workforce made economic sense (Blake,2008).

An American researcher (Fabius, 2013) tested the hypothesis that a company's stock market performance could be influenced by comprehensive and well implemented WPWP's aimed at reducing health and safety risks. By studying a wide range of companies recognized for having award winning health and safety programs, he concluded that such companies had a competitive advantage in the marketplace which resulted in greater value for their investors than companies that did not have such programs. Fabius's (2013) study concluded that these companies overall demonstrated 20% more revenue per employee, 16% higher market value and 57% higher shareholder returns. The research may have also identified an association between companies that had well executed health and safety programs and focused on other aspects of their business equally well resulted in higher overall returns.

In stark contrast to ROI claims of WPWP providers, research by RAND, a non-profit research organization, demonstrated the contrary by putting the ROI into proper perspective. The head researcher for RAND, Dr. Soeren Mattke stated, "The PepsiCo program provides a substantial return for the investment made in helping employees manage chronic illnesses such as diabetes and heart disease…But the lifestyle management of the program, while delivering benefits, did not provide more savings than it cost to offer" (Mattke, Liu, Caloyeras, Huang, Van Busum,

Khodyakov & Shier, 2014). The Pepsico Study concluded that 87% of health care costs come from chronic disease management programs such as for diabetes and cholesterol screenings etc., with only a 13% employee participation rate, while Life Style wellness programs such as exercise, eating better etc., account for only 13% of the costs savings yet have an 87% employee participation rate (Mattke et al., 2014).

3.5 On-Site MSD Intervention Programs: Evidence and Practice.

The On-Site approach to MSD intervention was the motivation for this thesis. The On-Site MSD intervention program evaluated in this study was founded in Lisbon Portugal in 2007. The approach consisted of prompt diagnosis and assessment, expert clinical management by Doctor of Chiropractic and physical therapists, restraint from bed rest, early mobilization, stretching exercises, ergonomic training, education, recommendations for physical activity, self-management and support for remaining in, or returning to work. The objective of the On-Site approach was to reduce the time of diagnosis, treatment and recovery that improved patient outcomes, returned people to work and reduced direct and indirect costs associated with MSD such as unnecessary clinical exams or referrals to several different doctors, diagnostic imaging such as MRI and CT scans, surgeries, disability, absenteeism, and lost productivity time.

According to a study (OPTUM 2013) which evaluated 14.7 million complete episodes of MSD complaints, non-surgical spine episodes were the top cost drivers. A comparison between time of entry for different providers determined the total cost difference for the episode. If a Doctor of Chiropractic, as was used for this study, was introduced, and spinal manipulation performed (by hand or instrumentation) within the first 10 days, the total episode cost was lower than for an MD (Medical Doctor)-PCP (Primary Care Physician) or physical therapist. The report stated that treatments were typically well-aligned with clinical evidence; the least fragmentation of care (not being sent to multiple specialists for evaluation), low rates of imaging, injections and prescription medications; and low total episode cost.

Part of the On-Site clinic offering was data collection, patient surveys and ongoing clinical research to determine the causes of MSD in the workplace and develop best practices. The On-Site MSD clinic model dealt directly with neck, low back pain and other MSDs. Research has shown that poor posture could lead to potential MSDs therefor, digital posture evaluation and ergonomic evaluation were an integral part of each patient initial consult. Employees were not

required to have severe pain or be on disability/work absence, to be evaluated and treated in the clinics. Most employees with poor postural habits presented with pain or discomfort while a surprising number were symptom free.

3.5.1 On-Site MSD intervention can be beneficial across stakeholders:

- For those living with MSDs, can help improve patient functionality, work ability and work productivity.
- For a Health care Professional, can facilitate timely, accurate patient flow, diagnosis and treatment, while helping to improve patient outcomes.
- For Health Systems, Hospitals, can help to improve efficiency and effectiveness of healthcare organization and delivery.
- From an employer perspective, can be useful in maintaining work ability and work productivity, thereby, helping to minimize presenteeism and absenteeism.
- For government, can provide a preventive pathway that enhances health and work ability and potentially avoids additional social and welfare outlays.
  (Fit for Work Europe, 2013), "Early Intervention: A cost-effective evidence-based solution to reduce the burden of MSDs"

3.5.2 Savings Strategies Across the Continuum of Care.

As the United States, transitions from a volume to value-based reimbursement system, the reimbursements are expected to decline. Given that hospitals are already surviving on thin margins (on average 2%), uncovering opportunities for savings is more important than ever. To achieve the level of cost-savings needed, traditional efforts are insufficient and more aggressive strategies are needed. The next wave of cost reduction will come from improvements in operational efficiencies and resource utilization, as well as improvements in the care delivery model. These changes include; steadfast improvements in integrated clinical operations, standardized protocols, coordinated care and population health care management (VHA, 2015).

In the context of Portugal and other European NHS's, the On-Site approach to MSD intervention could best be exploited by private and public sectors working together to save costs. This is the motivating force for this research.

WPWPs are generally missing a solution for MSDs in the workplace (Shortlister, 2019). The On-Site approach has been shown in Portugal to be an effective cost savings strategy. The future research could potentially reveal if the same strategy will be as effective in the U.S. market. In theory, the direct medical cost savings for U.S. companies should be significantly greater than their European counterparts due to the high cost of health insurance and the cost of medical care in the U.S. (KFF, 2019).

3.5.3 Private and Public sector co-participation in health care costs.

As stated earlier, one of the research objectives is to bring together the private and public sectors so that both sides can benefit from an On-Site intervention strategy for MSDs. By splitting the costs of establishing an On-Site clinic, the public sector social health systems or NHS such as in Portugal, will reduce costs by reducing medical consults, surgeries, unnecessary diagnostic testing, and reduce social security payments for short and long-term work disability from missed days' work. The private sector will have the benefits of a healthier workforce, reduced absenteeism, increased productivity and increased market competitiveness as well as increased shareholder returns and company profits.

3.6 Health Economics:

This project falls under the topic of Health Economics, a branch of economics with a focus on health care systems in the context of effectiveness, efficiency, value and stakeholder (consumer and provider) behaviors. The health economists study the impact of behaviors and how they impact functioning of the health care systems in which they exist such as alcohol use, smoking, obesity etc. Health economists evaluate multiple types of financial information: costs, fees for service and expenditure.

Medical Economics is a branch of economics often used interchangeably with Health Economics. According to Culyer (1989), medical economics is the application of economic theories to problems and phenomena typically associated with physician and nurses' markets as well as institutional services markets. More commonly however, medical economics pertains to cost-benefit analysis and cost-effectiveness of various medical treatments and pharmaceutical products.

Cost-effectiveness analysis (CEA) refers to the form of economic analysis that compares the relative outcomes of two or more courses of action and is appropriate for the purposes of this

study's cost and temporary work disability comparison between On-Site and Off-Site interventions for MSDs. According to Gold (1989), CEA is often used in the field of health services and is expressed as a ratio where the denominator is a health gain and the numerator is the cost associated with the health gain.

Williams (1987) summarized the scope of health economics in his "plumbing diagram" (*Figure 6)* below into eight distinct topics that are highly relevant to this research project.

- What influences health? (other than health care)
- What is health and what is its value?
- The demand of health care.
- The supply of health care.
- Micro-economic evaluation at treatment level.
- Market equilibrium.
- Evaluation at the whole system level.
- Planning, budgeting and monitoring mechanisms.

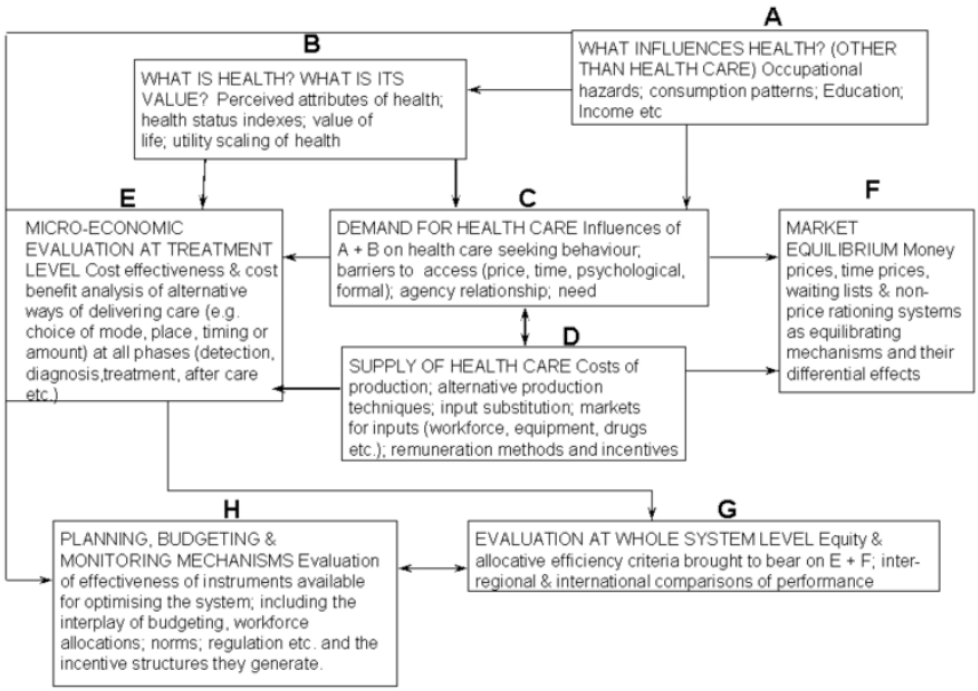


Figure 6 Health Economics Diagram

3.7 Reflective summary about theories and practice on Work Place Wellness for MSD

In summary, current WPWPs primarily focus on chronic illness and disease prevention, typically demonstrate an ROI for the organizations which adopt such programs, though the evidence as to just how effective, and why, varies widely. The U.S. programs appear to gain the greatest direct cost savings through direct cost reductions by keeping employees out of emergency rooms for non-life-threatening situations such as the common cold or flu, and by monitoring employee health issues such as diabetes and high blood pressure. Quite simply, MSDs are not represented as an important, chronic illness to be avoided or treated among the typical WPWP in the U.S., U.K. and Europe (Fit for Work, 2016). Workstation ergonomics appears to be the managers "check in the box" for addressing MSDs, but actual On-Site treatment clinics are extremely rare. There is much work to be done to educate managers as to the potential and existing as well as ongoing direct and indirect costs associated with MSD in the workplace. In the context of Work Place Wellness programs, this research and its research questions will contribute to filling the research gap concerning the actual impact MSDs have on employee productivity, absenteeism and associated costs from a much deeper perspective than previous studies that only measured sickness days missed from work.

4.0 KNOWN STUDIES: ON-SITE AND OFF-SITE CASE STUDIES.

This section will discuss some individual case studies and the respective results each approach had on healthcare cost outcomes for organizations. Both On-Site and Off-Site interventions will be discussed as to their objectives, approach and outcomes. An in-depth evaluation of 20 studies is located at the end of the Appendix section. What is missing from the literature is a comparison between On-Site and Off-Site interventions, specifically for MDSs. The author did not find any studies that measured absenteeism and associated costs caused by treatments, consults or diagnostics. the author, also, did not find any studies that directly measured the impact on productivity of specific MSD conditions such as neck pain, upper extremity pain, mid-back pain, low back pain and lower extremity pain.

4.1 Off-Site MSD Studies: A Synopsis.

The Off-Site MSD intervention studies selected were performed in Ireland, Sweden, Denmark, Canada, Spain and one in Istanbul Turkey. The primary objectives of the studies were to evaluate the effectiveness of different approaches to MSD interventions. Effectiveness in most cases was measured by the impact each approach had directly or indirectly on absenteeism (Fit for Work, 2013; 2014), return to work time periods, percentage of long and short-term disability claims (Leech, 2004) as well as costs to the NHS for providing said strategies and savings for the NHS of the respective countries in which the studies were performed (Durnad, Corbière, Coutu, Reinharz, & Albert, 2014; Arnetz, Sjögren, Rydén, & Meisel, 2003). Some strategies for attempting to reduce MSD related work absence found in the literature included, early intervention (EI) (Abásolo, Blanco, Bachiller, Candelas, Collado, Lahas, Revenga, Ricci, Lázaro, Aguilar, Vargas, Gutierrez, Garcia, Carmona & Jover, 2005; Leech, 2004; Bültmann et. al., 2009), using randomized controlled trial (RCT) methods using 12 months follow up physical evaluations and questionnaires to determine the patient's clinical outcomes and or resolution of the chief MSD complaint, allowing them to return to work full or part time.

The Madrid study (Abásolo et. al., 2005; Fit for Work, 2014), was the inspiration and the foundation of this thesis project. It was performed in three different health districts in Madrid, Spain, using a population-based MSD intervention program with 13,077 participants aimed at

reducing the number of and the direct costs of temporary work disability (TWD) and permanent work disability (PWD).

Method: A randomized, controlled intervention study. The conclusions and follow-up periods each lasted 12 months. The subjects of the study were taken from a pool of patients with MSD-related temporary work disability during 1998-1999. The control group were referred to standard primary care management and to specialized care if needed. The early intervention group were sent to a specific program administered by rheumatologists. The care was delivered during regular visits which included 3 main elements: education, protocol-based clinical management, and administrative duties.

The researchers measured two efficacy variables. 1) days of TWD (Temporary Work Disability) and 2) number of patients with PWD (Permanent Work Disability). Patients from the various districts in Madrid experiencing MSDs were seen by primary care physicians to be evaluated for their condition and provided a temporary work disability form. The patients who were experiencing MSD pain not caused by cancer, nerve entrapment syndrome, work trauma or surgery but from acute or chronic low back, neck and or extremity pain were qualified for the study. They were randomly selected to participate in the intervention group and contacted as soon as possible after the initiation form was issued.

The intervention group were consulted by rheumatologists in each district and seen as often as needed until the episode of temporary work disability was resolved or recovery was deemed improbable. Intervention in the study group included regular visits, education on self-care, ergonomics, movement and management of the condition, clinical management using primarily pharmaceuticals and administrative duties performed by the doctors and staff such as filling out forms, writing prescriptions and reports for the Inspection Services.

The intervention group consisted of three levels of care. The time spent in the first level was between 2-6 weeks and included diagnoses, medication for pain and inflammation and education. At the second level, patients received maintenance of pharmacological therapy, physical therapy or rehabilitation, diagnostic imaging such as x-ray, magnetic resonance (MRI) or computerized tomography (CT) and electromyography (EMG). If patients did not demonstrate improvement after 4-6 weeks, they advanced to the third level for further diagnostics or surgical consult.

Treatment failures that were non-surgical cases were further evaluated for what the researchers referred to as "yellow flags" including psychosocial causes, mental illness, family problems or work conflicts. The patients stayed on TWD if full recovery was deemed unlikely.

The measurements included**:** Episodes of TWD due to MSD were defined by the start of the episode (the day the initiation form was issued to the patient) and the conclusion (the day the end form was issued) by the attending physicians. The efficacy measures between the two groups were, 1) the duration of all episodes of MSD-related TWD per patient. 2) the number of such episodes per patient and 3) the number of proposals for PWD.

Effectiveness was measured as the percentage of days saved that a patient was on TWD and a total number of days on TWD saved in the intervention group. Cost-efficacy was defined as the total expenditure required to save one day of TWD. *Cost-benefit* was defined as money invested divided by money saved. *Net-benefit* was defined by money saved minus money invested. The episodes of temporary work disability in the intervention group were shorter than in the control group (mean, 26 days compared with 41 days) with similar numbers of episodes per patient. In the intervention group, fewer patients received long-term disability compensation than in the control group. Direct and indirect costs were lower in the intervention group compared to the control group. The program's net benefit exceeded $5 million. Evaluation of the study's costs demonstrated that $6.00 had to be invested in the program to save 1 day of temporary work disability which translated to each dollar invested in the program generated a benefit of $11.00.

This was proven to be a cost-effective program when offered to the general population which reduced short and long-term work disability outcomes.

The research on the clinical care methods of MSDs in the 1990's and 2000's done by Fit for Work Europe revealed that it is common for patients with MSDs to be treated primarily by physiotherapists (Frizell, 1995; Hannson & Hannson, 2000). It must be noted that previous research has failed to show clear impacts on health or return to work of interventions performed by single physicians and physiotherapists (Guzmán, Esmail, Karialinen, Malmivaara, Irvin & Bombardier, 1995; Hannson & Hannson, 2000, Starro, 2004). Unfortunately, the evidence base is weak concerning the effectiveness of specific rehabilitation programs designed to treat MSDs (Karialainen, 2003). If assessment and rehabilitation procedures have not changed, it would stand to reason why the intervention and control groups have similar development with regards to health

status and sick leave (Storro, 2004). A possible explanation for what appears to be a lack of impact on sick leave in some studies is that there were better opportunities for collaboration and intensified rehabilitation as the result of a co-financing model but it was not translated into positive impact on the patients' health or ability to work because the working procedure did not really change and the treatment methods applied lacked solid outcome evidence (Hultberg, 2004; Karialainen et al., 2003; Storro, 2004).

4.2 On-Site Primary Care studies: A synopsis.

The On-Site primary care studies were performed in the U.S., Canada and the U.K. Only one study, Canadian, included work related musculoskeletal disorders (WMSDs) in a hospital setting (Koehoorn, 2006). The purpose of the study was to evaluate the medical utilization rate of employees with WMSDs before, during and after workers' compensation periods compared to those without WMSDs. It was not an intervention study. Few other studies could be found which included On-Site interventions for MSDs. The concept of On-Site clinics in the U.S., U.K. and Canada, leans toward primary care medicine performed by nurse practitioners (Klepper, 2013; Mercer, 2015; Chenoweth et. al., 2005; 2008). The purpose of the primary care approach is the reduction of health risk factors such as high blood pressure, high cholesterol, high blood sugar which could lead to more serious and expensive health issues such as heart disease, stroke and diabetes (Mills, Kessler, Cooper, & Sullivan, 2007; Tao, Chenoweth, Alfriend, Baron, Kirkland, & Scherb, 2009; Mercer, 2015).

In doing a search for articles in scientific journals with studies on the impact of On-Site primary care clinics, very few recent (2010-2016) scientific journal articles were found. What did arise from the search process were several industry articles produced by consulting firms primarily in the United States as well as articles in reputable mainstream journals and periodicals but are not included in this section. To present information in a scientific manner, the author has chosen only published studies for this discussion. There is an explanation as to why there appears to be a shortage of published scientific studies. According to Pelletier (2009) in his analysis of workplace health care studies, he notes that there has been a marked decline in both the quantity and quality of studies since 2004. He attributes this phenomenon to an increased demand by corporations looking primarily for clinical and cost outcomes to justify their investments in chronic disease management and health promotion. Of the 16 studies, he evaluated, only one study was of true

experimental design while the others were financial outcomes case studies of lower quality. This is an industry trend that he believes may potentially have a negative impact on the field of corporate health and disease management research. A report by the WHO European Working Group on Health Promotion Evaluation, targeting policy makers (WHO, 1998), may explain a possible reason for this trend: *"The use of randomized control trials to evaluate health promotion initiatives is, in most cases, inappropriate, misleading and unnecessarily expensive."* (Pelletier, 2009; Bauer, Heller, & Challah, 1985).

Of the 10 On-Site primary care studies evaluated, there were three which were of interest for this thesis as they provided useful and effective approaches to healthcare delivery and methods to cost-benefit analysis. Study number 13, "*Integrating primary care with occupational health services: a success story"* (Griffith & Strasser, 2010), was one of the few On-Site approaches that evaluated the effectiveness of integrating primary care with physical therapy and other healthcare providers. The researchers performed a pilot study of an On-Site primary care clinic among a self-insured manufacturing company's employee population of 10,000 people. Two clinics were established to service two campuses. The services included occupational health services, physical therapy, primary care, urgent care, uncomplicated illness treatment and vaccinations. The clinics were staffed with primary care physicians, nurse practitioners, physical therapists and other health care professionals. The clinics were established to manage risks previously identified via risk appraisals among the employee population. The hypothesis of the study was that providing On-Site healthcare would reduce total healthcare expenditure for the employer and save money for employees. A thorough ROI projection evaluation study was performed to determine the costs of establishing a clinic, including physical space needs, staffing needs and the scope of practice that would be provided. The evaluation of employee health claims data assisted in the predictive cost of service if provided On-Site.

Metrics for the evaluation:

- Number of primary care worker encounters.
- Number of all visit encounters.
- ROI
- Customer/patient satisfaction ratings, including convenience of having On-Site care available.

The pilot clinics were operating with a positive cash flow within the first year. The key outcome metrics exceeded projections as well as benchmarks for similar clinics. In conclusion, the results of this study clearly pointed to the cost benefits of the On-Site model. Interesting to note that the use of physical therapy services for MSDs such as low back issues was a primary driver of the high performance compared to the benchmark clinics.

Study 14; "*A benefit-cost analysis of a worksite nurse practitioner program: first impressions".* (Chenoweth et. al., 2005), and the follow up study 14a, "*Nurse practitioner services: Three-year impact on health care costs."* (Chenoweth et. al., 2008), provided an excellent foundation for cost-benefit analysis methodology. The study took place in an industrial metal/plastics manufacturing firm. The objective of the study was to assess the financial impact on health care costs by using an On-Site nurse practitioner for the care of 4,284 employees and their dependents. The researchers analyzed the health care costs by two methods. First method: They compared annualized actual values for the first 6 months of the start-up year (2004) with those projected for 2004 based on an evaluation of claims paid in 2002 and 2003. Both aggregate and per-individual health care claims were used as the basis of comparison. The "benefit" of the nurse practitioner program was defined as the difference in health care costs between projected and real cost values for 2004. Second method: Health care costs were calculated using 2003 paid insurance claims for major diagnostic categories. These health care claims were compared with claims that would have been incurred for the same major diagnostic categories addressed by the nurse practitioner had they been addressed Off-Site in 2004. The benefit-to-cost ratio used the cost of the nurse practitioner ($82,717) as the denominator and used the savings in health care claims estimated by the two previously mentioned methods.

Cost Benefit Ratio used: Net benefit being the reduction in medical costs, disease or disability.

Net Benefit = **[**ΣL$ + ΣGP + ΣPI**]** – C

- ΣL$: direct benefit is the reduction in medical care costs, disease and disability.
- ΣGP: increased productivity leading to increased output and income.
- ΣPI: gain in working income due to reduced illness, injury and impact on absenteeism (lost income).
- C: cost of intervention in this case, the Nurse Practitioner.

The results of the study were the following; the savings in health care costs using method #1 were $1,313,756 per year with a benefit-to-cost ration of 15 to 1. Method #2 using major disease category analysis yielded a ratio of 2.4 to 1. The authors partly attributed the difference in ratios to the effects of a concurrent wellness program and 24/7 Nurse Health Line. They noted that the Nurse Health Line was established 10 months prior to the nurse practitioner program and contributed to workers and dependents avoiding costly emergency room visits.

The evaluation of the first six months of the nurse practitioner initiative yielded significant reductions in health care cost justifying further evaluation and follow up over a longer period. The same research team did a three year follow up study discussed below.

Study # 14a: "*Nurse practitioner services: Three-year impact on health care costs*" (Chenoweth et. al., 2008), based on the favorable results of study #14 above, the researchers did a three year follow up study to analyze the impact of providing On-Site Nurse Practitioner services had on health care costs. The same methods and measurements were used to evaluate the financial impact of the nurse practitioner program. Method 1 compared actual health care costs for 2005 to 2007 verses projected health care costs, the latter based on medical payments in 2002 to 2004 prior to the nurse practitioner intervention. Method 2 as in the first study, compared the health care costs of major diagnostic categories which accounted for 88.5% of all conditions the nurse practitioner treated between July 2005 to December 2006. The results of the follow up study were favorable. The cost of the nurse practitioner program during the study was $124,750. Using method 1, the savings in health care costs were $1,089,466 per year resulting in a benefit-to-cost ratio of 8.7 to

1. Using method 2, the savings in health care costs yielded a 2.0 to 1 ratio. As in the previous study, the authors comment that some of the health care cost savings using method 1 may have partially resulted from the use of the 24/7 Nurse Help Line. As in the previous study, the 3-year analysis confirms the positive benefit-to-cost findings that resulted with the implementation of the On-Site nurse practitioner program. Substantial savings have been achieved since the program started but one should keep in mind the parallel wellness programs and Nurse Help Line which also contributed to employee awareness and the avoidance of expensive Off-Site interventions.

As the hypothesis of this thesis is to demonstrate that an On-Site MSD intervention is more cost effective than Off-Site interventions the above studies demonstrate the merger of two approaches to health care with different financial objectives and priorities. The Madrid study targeted MSD

early intervention as a strategy to reduce lost productivity by reducing the number of days a patient needed to wait for care and by reducing the number of days a patient was on disability. MSDs were identified as a primary cause of work absence and disability claims as well as direct medical costs to the NHS. This MSD focused approach streamlined the patient processing process and avoided unnecessary or inappropriate medical consults. The approach was highly cost effective with an estimated 10:1 ROI.

The On-Site approaches to primary health care delivery also yielded a favorable ROI for the large, self-insured organizations in the United States and Canada. The studies did not, for the most part, include MSD intervention. The savings came primarily by having health care professionals easily accessible, permitting rapid intervention, for less cost than Off-Site. These organizations offered treatments and consults for a lower cost than the local market by comparing to previous years' health care insurance claims.

The connection of these two approaches, MSD intervention focus, and On-Site health care delivery, should yield a positive ROI. In theory, if MSD is addressed On-Site, the ROI should be even greater than the Madrid study considering that the patient processing would be even more effectively streamlined, removing unnecessary steps, unnecessary diagnostic imaging, surgery avoidance and reducing waiting times as well as reducing the burden on the NHS. It is also possible in theory that temporary work disability would be reduced or even avoided completely if an employee had immediate and direct access to an MSD specialist in the workplace. Also, in the context of On-Site, not only would medically related absenteeism be reduced but also direct medical costs associated with MSD, thus reducing the financial burden on the self-insured organizations in the United States. The On-Site MSD intervention has global appeal and benefits depending on the priorities and objectives of respective nations.

4.3. Known Studies Table: Studies 1-10 Off-Site studies, Studies 11-21 On-Site studies.

(Detailed Review of the studies in the Appendix section, Item 9.)

Table 1 below represents 21 known studies on the financial and clinical effectiveness of different approaches to employee health care. Each of these studies was considered when searching for the appropriate methods to be used for this thesis project. Studies 1-10 are from Off-Site MSD intervention studies, and studies 11-21 are from On-Site employee health care studies with only a

few being MSD intervention strategies, since On-Site providers focus on primary medical care and very rarely if ever on MSD treatments. There were no studies which compared econometric outcomes between the On-Site models and the Off-Site models of health care interventions.

Table 1 Known Studies Chart

Setting	Method	Conclusion	Comment	Reference
WHERE	HOW	FINDINGS	Anyway	
1: Ireland	Case Study: 3,300 working age disability claimants with Low Back Pain. - Early intervention group - Diagnostic triage group	• EI group • Increase % return to work • 40% reduction in claims • »£560,000 savings over previous year	EI proven clinically and cost effective	Leech, 2004
2: Sweden	Randomized controlled study: Stepwise procedure; 194 care-seekers with MSDs on work disability-(ages 18-65) Intervention group. 381 Control group - Physical therapy evaluation & questionnaires - Psycho-physiological eval. Cognitive Behavioral Therapy (CBT)	-Reduced social security expenditure. - Reduced sickness allowance costs/compensated days.	Effective	Andersen, et al., 2008
3: Denmark	Coordinated and tailored work rehabilitation (CTWR): Randomized controlled trial. MSD patients on sick leave. Measured cumulative sickness absence with 12 month follow up.	CTWR group had significantly lower sickness absence hours compared to the control group. CTWR resulted in a total cost savings compared to control group estimated as US $1,366 per person at 6 months follow-up and US $10,666 per person at 12 month follow-up.	Efffective	Bültmann et. al. 2009
4: Sweden	Interviews of patients aged 16-64 with MSDs treated in clinics with (n=107) and without (n=31) co-financed models to measure sick leave days over 18 months.	No significant difference in sick leave days between the groups.	Ineffective. The theory was that a co-financed model would be more efficient therefor reduce work absence. Not the case.	Hultberg, et al., 2006
5: Ontario, Canada	Evaluation of WMSD interventions in a large newspaper employee population. Qualitative and quantitative measures of	The evaluation framework research did not result in a direct reduction of WMSDs but allowed for evaluation of the	Research was designed to build a framework but	Cole & Wells, 2002

	strategies, activities, objectives to prevent or reduce WMSDs using a framework approach	broad spectrum of organizational changes required for future analysis and WMSD prevention.	was not tested fully as to WMSD reductions. (little to no reference to correct posture)	
6: Madrid, Spain	Randomized, controlled intervention study. The inclusion and follow-up periods each lasted 12 months. To evaluate whether a population-based clinical program offered to patients with recent-onset work disability caused by MSDs is cost-effective.	Reduced absence from work average from 41 days to 26 days. Each dollar invested generated a benefit of $11.00. Programs net benefit was in excess of $5 million	Highly cost-effective approach to MSD intervention. Improved long and short-term disability outcomes.	Abásolo et. al., 2005
7. Montreal, Canada	Exploratory study. Constructing the program impact theory for evidence-based rehabilitation for workers with low back pain using different data collection strategies to build the final program. • analyses unpublished documents. • scientific literature analyses. • Interviews • Discussions • Observations	Allows program designers, researchers and practitioners make evidence-based decisions when developing a similar program.	Using this methodology for program design opens up funding for rehabilitation programs based on evidence that the programs will achieve their expected outcomes.	Durand, 2003
8. Sweden	A prospective controlled trial study using insurance health care managers and ergonomists in the evaluation and management of MSD cases among employees. To test the time and cost impact on absenteeism.	Significant decrease in MSD related work absence, 50% decrease in time required to manage the cases, $1,195 savings per patient and a greater than 50% increased likelihood that the employee would return to work	Effective	(Arnetz, Sjögren, Rydéhn, & Meisel, 2003)
9. Istanbul	A prospective randomized controlled study to evaluate the effectiveness of an ergonomic approach to reducing MSDs among a population of computer workers. • Questionnaires • Interactive training • Educational brochures	• Improved body posture. • Improved workstation ergonomics. • Decreased pain. • Increased functional capacity. • Improved quality of life. • No impact on work absence.	Effective	(Esmaeilzadeh, Ozcan, & Capan, 2014)
10. Canada	A literature review of best work-absence management and return-to-work practices for workers with musculoskeletal or common	Identified a six-step process for organizations to address work absence:	Following the processes listed, typically improved the rates of	(Durand et. al., 2014)

	mental disorders. 17 articles reviewed.	1. *Time off and recovery period.* 2. *Initial contact with worker.* 3. *Evaluation of the worker and his job tasks.* 4. *Development of a return-to-work-plan with accommodations.* 5. *Work resumption.* 6. *Follow-up of the return-to-work process.*	employee returning to work sooner.	
On Site	**Primary Care Clinics Non MSD**	**Studies & Articles**		
11.U.S.A.	Longitudinal cost study analysis of 4 on- site clinics offering primary care medicine. Costs framed against the Milliman Medical Index	Initial cost increase due to utilization of free clinic in the first 6-14 months. Cost stabilized and dropped in most cases.	Effective but long time frame for financial returns. Did not include MSD interventions. Many factors drive costs that require multi-vector risk management approach.	(Klepper, 2013)
12. U.S.A	Questionnaire with 134 respondents for large employers with 5,000+ employees and offer work-site or near-site primary care clinics for employees and dependents.	Overall high satisfaction rate with utilization and health care cost savings, decreased work absence and increased productivity.	No MSD component mentioned	(Mercer, 2015)
13. USA	Pilot study of integration of occupational health with a primary care clinic. Employee population 10,000+	High # of employee visits High patient satisfaction + ROI at year 1 Exceeded benchmarks	Success Included Physical therapy.	(Grffith & Strasser, 2010)
14. USA	Benefit-cost analysis of worksite nurse practitioner program. Compared costs and predicted costs pre/post	High ROI within first year of use. Savings of over $1million.	Success No physio	(Chenoweth et. al., 2005)
14a. USA	3 year follow up of above study	Savings exceeded $1 million per year for the 3 years.	Success Good model for study	(Chenoweth, 2008)
15. USA	Cost-benefit tool. Study of Pepsi Bottling Group-33,000 employees,26 clinics.	Low ROI until end of month 12 than plateau. Rate of ROI based on population size and utilization.	Success	(Tao et. al., 2009)

16. USA	Literature review of clinical cost-effectiveness of 16 disease management programs studies from 2004 to 2008	Quantity and quality of studies have declined since 2004 with fewer RCT studies and an increase in quasi-experimental and pilot studies.		(Pelletier, 2009)
17. USA	Evaluation of 9 companies, approaches to employee weight loss programs. Employee populations ranging from 100 to 3,000. Success measured by weight loss and decreases in blood pressure and cholesterol.	Innovative approaches were revealed that looked to be promising practices for companies looking for effective strategies for a weight loss program.		(Hersey et. al., 2008)
18. Canada	Cost and medical utilization rate comparison for employees with WMSDs, based on medical claims data. Hospital setting. 5,029 employee medical records evaluated.	Employees with WMSDs have a higher rate of medical service utilization pre-during and post workers' compensation periods.	Evidence supporting the need for MSD interventions	(Koehoorn, 2006)
19. U.K.	Impact study of health promotion program on employee health risks, absenteeism and productivity. Quasi-experimental, Questionnaires at start and at 12 months.	Reduction in health risk factors Reduction in absenteeism Increase in work performance.		(Mills et. al., 2007)
20. USA	Self-paced exercise program for office workers. 3-month quasi-experimental prospective study. Measured success by weight loss, body fat reduction and lower blood pressure.		Low participation and high drop-out rates. Success story in general.	(Low et. al., 2007)
21. U.S.A	**1 million participants** **"Measuring Health-Related Productivity Loss** ***This study formed the foundation as to the instruments and methods used for this thesis.***	**2 Questionnaires.** **1. Absenteeism (days per year) and** **2. Productivity (WLQ), related to several common health risks and health conditions.**	**Strong correlations between illness, absenteeism and lost productivity.**	(Mitchell & Bates, 2011)

4.4 Critical reflection on known Off-Site versus On-Site studies.

The above studies were researched to learn what methods could be used for this study and to look at the greater body of knowledge as to how MSDs are being treated in the workplace and what approaches were successful in reducing disability and costs. The research revealed On-Site solutions to general medical treatment, but few designed specifically for MSD. The Off-Site models, mainly Early Intervention (EI) studies, addressed the MSD issue in the context, primarily of disability days missed from work but did not measure the impact on productivity.

In the search for validated methods to measure productivity and absenteeism, one large scale study served as the foundation for the final study used for this thesis. A study, "Measuring Health-Related Productivity Loss" (Mitchel & Bates, 2011) was designed to determine the relationship between health status and productivity loss (and absenteeism) and to provide estimates of the business implication of lost work performance. The study consisted of over 1 million participants who were also members of the same insurance plan in the U.S. It was a phone-based study that used one questionnaire to determine absenteeism and another to determine productivity losses, both associated with health issues. Absenteeism was measured by asking participants how many days in the past year they missed work due to a list of health issues that were determined by their insurance claims. Response choices were based on a scale of "1-2 days", "3-5 days" , "6-10 days" etc. A continuous variable was created by recording response options to indicate the total work days lost per year because of absenteeism (e.g., "1-2 days" was recorded as 1.5 days, "3-5 days as 4 days etc.), (Mitchel & Bates, 2007). This exact method was applied to this thesis study. The same study measured productivity losses due to personal illness and how they impacted work performance. The Work Limitations Questionnaire (WLQ), developed by Lerner (Lerner, 2005) was used for its advantage over other productivity loss instruments in that, it has shown strong validity and reliability in several workplace settings, and it has been used for extensive testing to measure general health impact and the impact of specific conditions. The study measured a wide range of illnesses, form allergies, arthritis, asthma, back pain, cancer, depression to headaches, pain, obesity, high cholesterol etc. With "back pain" and "arthritis" among the list, using the WLQ appeared to be the appropriate choice for this thesis study to measure the impact of MSDs on productivity.

What is missing among the research studies is, the comparison between On-Site and Off-Site interventions and how the location of the clinic impacts the variables of productivity and absenteeism and resulting costs. No studies were found in the literature which evaluated absenteeism in quite the same way either, presumably because the literature review revealed that there is much uncertainty concerning any standardized methodologies to measure absenteeism or even how to define absenteeism (Johns, 2003; Bradford Factor, 2006; CIPD,2007; DMAA, 2009; Towers Watson, 2009/2010; Genowska et al., 2017). Therefor, the research questions of this study fill the scientific gap derived from the actual science.

PART B. EMPIRICAL STUDY: OUTLINE.

The empirical study is presented in the following sections. The first section, 5.0, is the context in which the study was performed, in this case, company's "A", "B", and "C" with a short description of each organization. Section 6.0 is a detailed description of the two research instruments used for the study, why they were chosen and their significance to the study. Section 6.3 is a description of the implementation of the study, including the time and data collection process and a research log of the days the studies were performed. Section 7 is a description of the raw data collected and a brief discussion of the initial findings for each of the questions and categories of the study. Finally, we provide discussion and presentation of the results with an explanation of the calculations used to reach the final figures of this study and finally statistical analysis of the findings and a summary of the results.

5.0 Organizations studied: Context

The study was a Field study in the context of not disturbing the environment that was being studied therefor not introducing artificial methods of data collection (Hammersley & Atkinson, 1995: 6). The research objective is to use an explanatory or causality approach of multiple cases to derive a detailed understanding of a particular phenomenon where the case is not seen as ancillary to more quantitative methods (Lee, Collier & Cullen, 2007). The phenomenon being the affect that MSDs in the workplace have on productivity, absenteeism and the associated resulting costs to the organization. Presenteeism and Absenteeism are measured from the perspective of the companies under evaluation. Presenteeism, lost productivity of people at work but not working to their full capacity was measured to establish if MSDs had an impact on productivity. Only the On-Site clinic populations were used for this study for logistical reasons and access to clinical data for further correlational investigation. The study was designed to evaluate whether an On-Site population-based clinical program offered to employees suffering with MSDs is more effective than an Off-Site program in addressing the phenomenon above. A comparison of On-Site vs. Off-Site costs were calculated by total hours missed from work caused by MSD related absenteeism factors including: 1) missed days: unable to be present to work on those days, 2) time away from work, measured in hours for MSD a) treatments, b) MSD external consults, and c) MSD related diagnostic imaging. The study included three corporate On-Site MSD intervention clinics located

in Lisbon, Portugal. Three organizations were used to collect data; 1. a utilities company, 2. a bank headquarters, and 3. a consulting/technologies/call center company. The three organizations were chosen for this study because they each utilized On-Site MSD intervention services to treat their employees. All three of the corporations' employee populations consisted primarily of white-collar, sedentary, seated, computer- based workers. Each organization consisted of similar employee populations yet different average age and generational mix. The age/generation groups consisted of Baby Boomers born before 1963, Gen X born between 1963 and 1980, and Millennials born between 1980 and 1995. The culture within each organization was quite different, thus the impact of their job responsibilities appeared to be an interesting factor to consider as a possible cause for varying productivity scores. A study perhaps better suited for another PhD thesis or Post Doc.

A detailed description of the three organizations is as follows:

5.1 The Utilities Company.

The utilities company has a large employee population of over 7,000, predominately, sedentary, computer workers with an average age of 53 years old at the time of this study. There is a small percentage of employees under care who perform more physical tasks working on electrical lines, lifting, bending, carrying objects and load baring maneuvers etc. as well as others who spend many hours driving. The population under care consisted mainly of Baby Boomers and Generation X. As an observation, the culture within this organization appeared to be more relaxed when it came to arrival at work, break times and punctuality.

5.2 The Consulting/Technologies/Call-Center.

The consulting/technologies/ call-center organization is a large international firm with a U.S. based business culture of high-performance demands and long working hours to complete projects on time and under budget. Again, most employees under care are sedentary workers spending long hours on computers, most of whom used laptops, resulting in chronically poor working postures. The average age of this organization's population is around 35, Millennials and Generation X. This organization has invested in the health and wellbeing of their employees. The employees

benefit from the On-Site MSD clinic, medical physician, psychologist and nutritionist services all provided On-Site.

5.3 The Bank Headquarters.

The bank headquarters has an employee population of over 4,000, sedentary computer using workers with an average age over 50 years old, mainly Baby Boomers and Generation X. The culture within this organization was very high stress caused by challenging fiscal and budgetary targets that several employees reported as unreasonable. Some employees reported that if they met their targets for the quarter or for the year, top management would not acknowledge a job well done, but would be critical that the targets must have been set too low. Management would set higher targets, thus creating more work-related stress. This was a common theme among the study group. Many reported that the pressures of the financial crises of 2008 until the time of the study in 2018 impacted their job satisfaction and that they attribute their work stress as the primary cause of their MSDs. (Information obtained during patient intake process).

6.0 Methods

6.1 Control:

The research used a multiple case study design and therefor a Correlational (posteriori control) design which allowed for comparison and contrasting of research findings between multiple cases with similar natural environments. The WLQ study allowed for a natural control group. Due to operational capacity limitations, not all the employees who had physical exams and who completed the WLQ questionnaire, were able to start treatment immediately. Between 40 and 50 employees in each of the three clinics were treated between August and December. The capacity limitation was due to pre-existing patients in each of the clinics that were under care at the time of the study. The employee/patients that could not be treated were put on a waiting list. This group served as the control for repeating the WLQ to compare the treatment group with the un-treated group. The control group for the *absenteeism measurement* portion of this study were employees with self-reported MSDs who sought care Off-Site as opposed to the group who were treated On-Site.

In theory, this would be a positivistic approach where the goal is to generate theory by extracting variables from their context as proposed by Eisenhardt (1989). The primary variable will be between On-Site and Off-Site approaches to MSD and their impact on absenteeism, presenteeism the resulting cost to the organizations evaluated. A single case study of one organization would not allow for comparison therefor making the research of lesser value. Other non-manipulable variables were the types of industries as well as the average age of the sample groups. Further, such non-manipulable variables included a comparison between male/female, banking, consulting and energy provider companies.

6.2 Research Instruments Used-Methods

Two research instruments were used for this study. The first research instrument used was a self-completion Likert Scale questionnaire in a digital format known as the Work Limitations Questionnaire (WLQ). It measures a person's self-reported limitations to productivity "in the past two weeks…". Presenteeism, the phenomenon of being at work but less productive due to the MSD, primarily neck and low back pain, was the context for which the WLQ was used. Only the

On-Site cohort were used for the WLQ due to access to clinical data and the option to do a future follow up study using the same sample.

Follow Up WLQ Study, Phase 2: The same 25 item long form WLQ questionnaire was used for the follow up study with only one change. The randomly selected participants were asked: "How many treatments have you received since your first consult? The options were: A. 0; B. 1-4; C. 5-8; D. 9-12 and E. 13-16 and converted to 2.5, 6.5, 10.5 and 14.5 respectively. "0" represents the Control group. Any other number represents the Test/study/treatment group.

The second tool was also a self-completion Likert Scale questionnaire to measure absenteeism related to the participants MSD issues, primarily neck and back pain, "in the past year…". Absenteeism was measured in the context of missed hours and days from work in the form of 1) missed work for external consults and treatments, 2) time missed from work for external diagnostics, and 3) time missed from work as total days missed (incapacity to work/disability) for bed rest etc. A total of seven questions.

6.2.1 WLQ Questionnaire (Work Limitations Questionnaire):

The WLQ is structured in the typical five-point Likert Scale and was used for the questionnaire. A Likert Scale is an orderly scale from which respondents choose the option that best supports their opinion. It can be used to measure someone's attitude by measuring the extent to which they agree or disagree with a question or statement (Smartsurve, 2017). The main advantage of Likert Scale questions is that they use a universal method of collecting data, it is easy to draw conclusions, reports, results and graphs from the responses. Another advantage, because Likert Scale questions use a scale, people are not forced to express an either-or opinion, furthermore, allowing them to remain neutral if they so choose. This tool was chosen because it is very quick and easy to implement thus removing a barrier to participation, furthermore, it could be presented through several modes of communication, including email when necessary, but was especially suited for the live clinical environment in a digital, on-line format.

The WLQ is a validated, widely used and simple to use questionnaire which measures the degree to which employed individuals are experiencing limitations on-the-job due to their health problems and health-related productivity loss (Lerner, Rogers, & Chang, 2002; Mitchel & Bates, 2011). The job demands, which are contained in the WLQ's items, have four defining features: 1) they occur among a variety of jobs; 2) many different physical and emotional health problems may interfere

with their performance: 3) they are considered important to the job from the worker's perspective; and 4) problems performing them are frequently related to productivity. The WLQ has 25 items that ask respondents to rate their level of difficulty or ability to perform specific job demands:

1. *Time Management Demands*: 5 Items. Handling Time and Scheduling demands.
2. *Physical Demands*: 6 items. Measures Strength, movement, coordination, endurance, flexibility.
3. *Mental-Interpersonal Demands*: 9 Items. Measures Cognitive job tasks and social interaction on the job
4. *Output Demands*: 5 Items. Measures work quantity and quality.

The scale score ranges from 0 (limited none of the time) to 100 (limited all of the time) and represent the reported amount of time in the prior two weeks respondents were limited on-the-job. Additionally, using an algorithm, WLQ scale scores can be converted into an estimate of productivity loss (Lerner et al., 2002).

"Productivity loss related to presenteeism was measured with the question: "In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?" Response choices were "all of the time (100%)," "most of the time," "half of the time (50%)," "some of the time," and "none of the time (0%)." The response options "most of the time" and "some of the time" were recoded to 75% and 25% of the time, respectively, and "does not apply to my job" and blank responses were set to missing. Survey items were combined into 4 work limitation scales: time management (ability to handle time and scheduling demands of the job), physical work (ability to perform job tasks involving bodily strength, movement, endurance, coordination, and flexibility), mental-interpersonal (ability to perform cognitive and interpersonal job tasks), and output (ability to produce work output in a high-quality or timely manner). Categorical response options were converted to percentages and resulting scale scores ranged from 0 (limited none of the time in the past 2 weeks) to 100 (limited all of the time in the past 2 weeks)" (Lerner, Rogers, & Chang, 2005).

The WLQ comes in a Short Form and the original 25 question Long Form which was used for this study. The original 25 question long form was provided in Portuguese (European) by Mapi Institute, the official distributer of the tool. The Portuguese version used for this study is provided in the Appendix section (Item 3). The questions and responses are described in English. The

WLQ began with simple instructions to orient the subjects as to what the research was about. The following opening statements included; "Health problems can make it difficult for working people to perform certain parts of their jobs. We are interested in learning about how your health may have affected you at work *during the past 2 weeks*.", and, "The questions will ask you to think about your physical health or emotional problems. These refer to any *ongoing or permanent medical conditions* you may have and the effects of any *treatments* you are taking for these. Emotional problems may include feeling depressed or anxious." For the context of this study, each participant was instructed to think in terms of how their individual musculoskeletal complaints, that lead to their being evaluated in the clinic, affected them in the past 2 weeks. The emotional component of the question at first glance, appeared not relevant to this study but was suggested by the developer of the instrument(Dr. Lerner), not to be removed, so as not to interfere with the authenticity of the instrument and also to see if MSDs did impact the emotional as well as the physical state of the subjects questioned. There was an option for; "Does not apply to my job" for items that were not part of their normal daily work activities. Question 1 was the Time Management section which included 5 items. Each question in this section started with; "In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?" 1.1. Work the required number of hours, 1.2. Get going easily at the beginning of the workday, 1.3. Start on your job as soon as you arrived at work, 1.4. Do your work without stopping to take breaks or rests, and 1.5. Stick to a routine or schedule. The response options were; 1. Difficult all of the time (100%), 2. Difficult most of the time, 3. Difficult some of the time (50%), 4. Difficult a slight bit of the time, 5. Difficult none of the time (0%) and 6. Does not apply to my job. Time management is an important skill directly related to productivity (Learner et al., 2001,2002,2005; Goetzel et al., 2004).

Question 2 was the Physical Work Tasks section of the questionnaire consisting of 5 items. This section was different than the previous section because they asked the subject to rate the amount of time they were able to handle certain parts of their job without difficulty. 2.1. "In the past 2 weeks, how much of the time were you *able to walk or move around different work locations* (for example, go to meetings), *without difficulty* caused by physical health or emotional problems?" 2.2. In the past 2 weeks, how much of the time were you **able** to lift, carry, or move objects at work weighing more than 10 lbs. (4.5 kilos)., *without difficulty* caused by physical health or emotional problems? 2.3. In the past 2 weeks, how much of the time were you **able** to sit, stand,

or stay in one position for longer than 15 minutes while working, *without difficulty* caused by physical health or emotional problems? 2.4. In the past 2 weeks, how much of the time were you **able** to repeat the same motions over and over again while working, *without difficulty* caused by physical health or emotional problems? 2.5. In the past 2 weeks, how much of the time were you **able** to bend, twist, or reach while working, *without difficulty* caused by physical health or emotional problems? and 2.6. In the past 2 weeks, how much of the time were you **able** to use hand-held tools or equipment (e.g., a phone, pen, keyboard, computer mouse, drill, hairdryer, or sander), *without difficulty* caused by physical health or emotional problems?

The options for this section were; 1. Able all of the time (100%), 2. Able most of the time, 3. Able some of the time (about 50%), 4. Able a slight bit of the time, 5. Able none of the time (0%) and finally, 6. Does not apply to my job.

Questions 3 and 4 were the Mental Interpersonal Tasks section. Again, this repeated the structure of question 1; "In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following? The responses were also structured the same as question 1 with "Difficult all of the time (100%), "Difficult most of the time"….etc. Question 3 consisted of 6 sub-questions; 1. Keep your mind on your work, 2. Think clearly when working, 3. Do work carefully, 4. Concentrate on your work, 5. Work without losing your train of thought and 5. Easily read or use your eyes when working.

Question 4 asked about difficulties in relation to the people the subjects came in contact with while working. These included employers, supervisors, coworkers, clients, customers, or the public. Same leading question and response options as questions 1 and 3. The 3 sub-questions included; 1. Speak with people in-person, in meetings or on the phone, 2. Control your temper around people when working, 3. Help other people to get work done.

Question 5 was the Output Tasks section with 5 sub-questions. These questions were intended to ask about how things went at work overall. The structure was the same as questions 1,3 and 4. The following 5 sub-questions were; 1. Handle the workload, 2. Work fast enough, 3. Finish work on time, 4. Do your work without making mistakes and 5. Feel you've done what you are capable of doing.

6.2.1a Scaling and Scoring Process

The following is the scaling and scoring process as written by the author, Dr. Debra Lerner of Tufts Medical Center in Boston and represented in *Table 2*. The WLQ used the 5-point Likert Scale ranging from 1: "difficult none of the time" to 5: "difficult all of the time" for questions 1,3,4 and 5 and ranging from 1:" able all of the time" to 5: "able none of the time" for question 2.

The WLQ is composed of 25 items investigating 4 domains. The digital, on-line version of the WLQ used for this study asked 25 individual questions, whereas the handwritten, paper and pencil version asked one question per section with a number of items for each as described in Table 2 below.

Table 2 WLQ Scaling and Scoring Diagram

Scales	Number of Items	Cluster of Items	Item Reversion	Direction of Scales
1-Time Management*	5	1. a-e Questions 1-5		
2-Physical Tasks	6	2. a-f Questions 6-11		Greater score = More self-reported difficulties at work. "Able none of the time"
3-4-Mental-Interpersonal Tasks*	9	3. a-f, 4. a-c Questions 12-20		
5-Output Tasks*	5	5. a-e Questions 21-25		

*item reversion follows the opposite direction of the scales. (Appendix *Item 4*, for more details)

Three scales use a frequency of "difficulty" response scale, (Time Management, Mental-Interpersonal Tasks and Output Tasks) and one scale uses a frequency of "able to" response scale, (the Physical Tasks scale). Each scale score ranges from 0 to 100 after conversion. Score indicates the frequency in the past two weeks of work limitations.

Step 1: Item Response Scores were assigned for each item using the numeric value described in "item scaling".

Step 2*: The Four WLQ Scales were scored by calculating the average item score and converted to the final score.* To obtain the final score with the average item score, the item scores were summed, and the result divided by the number of items with non-missing answers. The average item score was converted to a 0-100 range using the following formula: WLQ Scale Score = 25(average item score-1). For example, if the Average Item Score is 2.25, the WLQ Time Management Scale Score can be calculated like this: 25(2.25-1) = 31.25.

Step 3: *Checking and Fixing Physical Scale Score Errors*. If the answers to the physical scale items contradict the answers in the other 3 scales, one can reasonably infer that the respondent didn't notice the change in the response options. For these cases, a physical scale score correction procedure was as follows; if the physical scale score computed in step 2 is greater than or equal to 75 and the other three scale scores are less than or equal to 30, the physical scale needs to be reverse scored by subtracting the original physical scale score from 100. Fortunately, this error was caught during the active questionnaire process and avoided the need to apply this formula.

Some people did not notice that the second group of questions had changed from "with difficulty" to "without difficulty". According to the developer, Dr. Lerner, this has been a common phenomenon of the WLQ and that researches should be alert to this possibility and make adjustments if necessary.

Step 4. Computing the WLQ At-Work Productivity Loss Score. The following formula was used:

WLQ Index = (□1*WLQ Time Scale + □2*WLQ Physical Scale + □3*WLQ Mental-Interpersonal Scale + □4*WLQ Output Scale)

Where □1 = 0.00048, □2 = 0.00036, □3 = 0.00096, and □4 = 0.00106

The WLQ Index was converted into the WLQ At-Work Productivity Loss Score with the following formula: WLQ At-Work Productivity Loss Score = (1-exp (-WLQ Index)).

For example, if the WLQ scale scores for the Time Management, Physical, Mental-Interpersonal, and Output scales were 25, 35, 25, and 40, respectively, the WLQ Index would be calculated as: 0.00048*25+0.00036*35+0.00096*25+0.00106*40=0.091.

Then the At-Work Productivity Loss score would be calculated as:

1-exp (-0.091) = 0.08698

The result is multiplied by 100 to express the score as a percentage of at-work productivity loss.

Note that all four scale scores are required to generate the WLQ Productivity Loss Score.

Interpretation and Analysis of the missing data. The blank response is considered as missing. If half or more of one scale's items have been answered, calculate the average item score and convert it to the final scale score.

For example, if a respondent answers 4 of the 5 items in the Time Management scale as follows:

Req hrs. 3
Get going 2
Start 1
Breaks
Routine 3

(This example uses the variable names specified in the WLQ Codebook to indicate each item within the Time Management Scale).

First, sum the item scores: 3+2+1+3. Then divide by the number of items with non-missing answers, i.e., divide by 4. Your answer is therefore 9/4 = 2.25.

If a respondent did not answer at least half of the items within a scale, the scale is set to missing and then cannot be scored.

Interpretation of multiple answers for one item: Take the average of the scores for the multiple answers.

Interpretation and Analysis of "not applicable" answers: The "does not apply to my job" response is considered missing and is coded as missing. If half or more of one scale's items have been answered, calculate the average item score and convert it to the final scale score. If less than half of one scale's items have been answered, the entire scale is set to missing and cannot be scored.

Interpretation of scores: The WLQ Productivity Loss score is interpreted as the percentage of at-work productivity loss in the past two weeks relative to a healthy benchmark sample. The benchmark sample consists of employees who had WLQ scale scores of zero (not limited by health). It is not necessary to further adjust scores by age, gender, or other demographic characteristics. The maximum attainable for WLQ index (with all scales at 100) is 28.6% and the maximum attainable productivity loss is 24.9%.

6.2.2 Absenteeism Questionnaire.

A digital/ on-line version of the questionnaire was created and utilized for each location of the study. The questionnaire was translated into Portuguese. Typeform was used for this study as well. (Annex Item # 7).

An introductory authorization letter was used that was very similar to the WLQ with the exception that participants acknowledge in question 1 via a simple "yes" or "no" question if they have used the On-Site facility or not. Those who replied "yes" have been patients of the clinics for at least one year. Those who replied "no" were volunteers who reported having MSDs for at least one year but have not received treatment at the On-Site clinic. This group served as a control.

Questions 2 through 6 were prefaced with the statement; "In the past year", to be consistent with other absenteeism scales used to measure absenteeism in days and hours (Goetzel et al., 2004; Mitchel & Bates, 2011). Question 2 asked; "In the past year, how many *days* were you unable to go to work due to your musculoskeletal conditions such as low back pain and neck pain etc.?" This question was used to determine a base level of work disability caused by the subjects' condition. It is likely that responses were conservative as recall over a one-year period can be variable (Goetzel et al., 2004; Mitchel & Bates, 2011). None the less, it was an important comparative metric to determine missed days as opposed to missed hours. The options were; a. 0 days, b. 1-2 days, c. 3-5 days, d. 6-10 days, e. 11-15 days and f. more than 16 days. Question 3 was designed to determine how much time, in hours, on average, the subject was away from work per consult. This was an important base line question, the result of which was applied to questions 4 and 6 as well for calculating total average missed work hours. The response options for question 3 were; a. 0 to 1 hours per consult, b. 1 to 3 hours per consult, c. 3 to 5 hours per consult and d. more than 6 hours per consult. Question 4 asked, in the past year, what doctors or specialists did they consult with for the diagnosis and or treatment of their musculoskeletal condition. The idea behind this question was three-fold. One; to see how many consults per condition there were on average, two; to calculate the number of hours for said consults based on question 3 results, and three; look for patterns in the continuum of care based on the subjects first contact entry into the medical system. The options were; a. Family Doctor, b. Orthopedic Surgeon, c. Neurosurgeon, d. Physiatrist, e. Physiotherapist and f. none of the above. Such information is valuable for future calculations of how much each case cost the Social Health System or in the case of the U.S., could

be calculated in direct costs per consult for the employer. Question 5 asked how much time passed between the onset of symptoms and the start of treatment. Only in a few cases of the subjects questioned, did they miss work between onset and treatment. This question was included for the sake of future studies for making a comparison with other Early Intervention programs throughout Europe (Fit for Work, 2013) which demonstrated a reduction in waiting times through their early intervention methods. The results were not used to calculate absenteeism for this study. The reply options were; a. 1 to 6 days, b. 7 to 14 days, c. 15 to 21 days, and d. more than 22 days. Question 6 asked what exams the subjects had done in relation to their musculoskeletal condition in the past year. This was also a multi-purpose question. One; for each exam performed, the average time per exam was used to calculate absenteeism related to the exam or exams selected. Two; To look for the most frequently selected diagnostic imagery and three; to look for patterns or correlations as to which health care professionals selected which exams. This data can be cross-referenced and correlated to see if such information could help determine different clinical practices among each specialty, thus help to determine the average cost of the continuum of care based on point of entry into the health system. Each exam has a different cost, and future studies or a more painstaking analysis of this data may demonstrate which is the most effective and economical path for patients to follow in cases of musculoskeletal conditions. An algorithm can be developed to determine the most cost-effective clinical path that could be applied to widespread or standardized practices among health systems. This question was designed primarily for this study to determine and compare the missed work hours of all diagnostic imagery for the On-Site and Off-Site MSD patients, but its future use is of far greater in the broader economic perspective.

6.3 Implementation of the study:

6.3.1 Time

As previously mentioned, the study was made in two phases that are described now:

Procedures for Phase 1: The data gathering process occurred between June 2018 and August 2018. A beta test was done with the WLQ and the absenteeism questionnaires to test for clarity, errors and adjust for misunderstandings. The two instruments were tested on 10 people from each location, a total of 30 for each, equaling 60 tests. The WLQ, question 2, which addressed physical tasks, caused confusion among the test group due to the wording being reversed to the previous question structure. This concern was addressed with the author of the instrument, Dr. Debra

Lerner, who commented that it is a common challenge among test subjects and that it is essential that it remain as it is. Dr. Lerner also stated that if an error is found, there was a formula to correct it during the scaling and scoring process. The absenteeism questionnaire presented no challenges to the test subjects and was straight forward. Many of the subjects had the exact number and dates for the past years consults in their mobile phones. Prior to the administration of the WLQ, the subjects, patients of the clinics, were processed over a four-week period in each of the clinics during the months of June and July. Surveys were filled in between July 26th and August 6th. A total of 100 working hours were logged by the clinical staff for the patient clinical data intake portion of the study. The Absenteeism questionnaire was completed on August 14 and August 16, 2018 using a team of six people working on-location within the three companies.

Procedures for Phase 2: The follow up WLQ survey included the patients under care between August and December 2018, as well as the control group, who were examined for treatment and completed the WLQ in August but did not receive care. This was performed between December 6th and December 13th, 2018 at each of the clinics.

6.3.2 Questionnaires

The study used two questionnaires, one for productivity, and the other for absenteeism, the implementation of both is explained in detail.

6.3.2a WLQ: Work Limitations Questionnaire.

The WLQ portion of the study was originally scheduled to begin in February 2018. Due to delays in the authorization process by legally responsible parties of U.E., the process was delayed until June 2018. The WLQ Portuguese form was approved by MAPI Research Trust the distributor, and the author, Dr. Debra Lerner of Tufts Medical Center Boston.

The approved digital/on-line, Portuguese version of the WLQ was acquired from MAPI and integrated into Typeform, an on-line questionnaire service (https://www.typeform.com/).

Questionnaire Link: (https://fisico.typeform.com/report/x7DjeS/f13wCnqHsOvaoVUI)

Dr. Debra Lerner approved that the format was accurate and appropriate for use in the study. No changes were made to the original questions as not to interfere with the psychometrics of the tool as suggested by Dr. Lerner (phone conversation, June 26th, 2018).

Location: On-Site Clinics, Company A, B and C. Objective was to have 100 patients from each location respond to the Phase 1 questionnaire.

Phase 1 Study: (July/August 2018): Total 270

Final Count: Company A: N = 70, Company B: N = 100, Company C: N = 100.

Phase 2 Study: 16-18 weeks follow up. (December 2018): With Control Group and Treatment Group, N = 173.

Final Count Control Group: Total: N = 87. Company A: N = 29, Company B: N = 30, Company C: N = 28

Final Count Treatment Group: Total: N = 86. Company A: N = 28, Company B: N = 28, Company C: N = 30

Participants were selected for the study from the three On-Site clinics based on their history with MSDs such as low back pain, neck pain, mid back pain, upper and lower extremity pain. A request for participation in the study was sent out in December 2017 and again in January 2018 in e-mail form to 2,357 patients from the three corporate data bases. The purpose was to use current and former patients to help in the recruiting process for new patients/ subjects, for the study. From this group, 522 potential subjects responded that they would be willing to participate in the project. Due to delays and further logistical complications caused by the May 25th, 2018 patient data protection laws implemented by Portugal, email communication became limited to intranet communications distributed by the HR departments of the three organizations due to uncertainty surrounding the new regulations (GDPR, 2018). July 2018 was the beginning of many potential participants yearly vacation time, thus reducing the potential sample size even further in some cases.

Phase 1:

Subjects selected for the WLQ technically became patients of the On-Site clinics and were processed by the teams of each clinic. Each subject underwent physical examination and history taking to determine their primary MSD complaints. The process took four weeks to complete. This data was collected on separate Excel sheets for each clinic and merged for the study. Posture photographs were taken of each person and a majority brought x-rays of their spines (67%). The

findings were included in the Excel sheets for further potential correlations and research. Between 30 and 40 of the newly processed patients in each company were put on a waiting list. This group served as the control for the post WLQ follow up in December. It also was necessary to allow time for those that needed treatment more urgently to be scheduled immediately. There was also an issue with capacity in the clinics. Though all the patients were processed for first consults, examinations performed and later WLQ forms filled in, there were not enough treatment times available in the clinics to provide care for everyone who participated, thus they were put on a waiting list until there was time available to start treatment. As such, patients were called as space became available in the clinics over a 16-week period, therefor, each of the participants started their treatment on different dates between August and December 2018.

Subjects completed the questionnaires on two lap top computers on location at each of the clinics upon their visit to one of the three clinics in the study. The WLQ and the absenteeism/cost studies were performed on different days, staggered approximately two weeks apart. This allowed for the questionnaire process to be integrated into the patients normally scheduled appointments. There was a Wi-Fi/ Internet connection problem on day one of the study in "Company A", thus reducing participation from "Company A" by over 30 people who showed up for the study but could not fill in the questionnaire.

The process only required approximately five minutes or of their time to complete and did not interfere with their schedules or require that they invest additional personal time in completing the survey. The average waiting time in all three clinics was typically between five and fifteen minutes depending on the time of day. This method also allowed for a nearly 100% compliance rate and willingness to participate. A total of 277 subjects fully completed the WLQ over a two-week period but only 258 were usable due to errors in patient number entries on the digital form. This only became clear upon evaluation of the Excel sheets. Scheduling did not allow for participants to repeat the questionnaire.

Phase 2:

For the follow up study, patients were randomly selected from the pool of 277 subjects who completed the WLQ during phase one. The control (N = 87) and the treatment/Study (N = 86) repeated the WLQ in December. For the treatment group, clinical data was collected at each visit to the clinic for care, to determine their symptomatology and record the number of treatments

received. This data was later merged with their new WLQ scores for the purposes of correlational statistical analysis. A Likert scale question was added to the beginning of the Phase 2 WLQ, asking participants how many treatments they have received during the period between Phase 1 and Phase 2. The clinicians transmitted this information to the patients taking the WLQ, as it was recorded on each of their electronic health records, thus they could select the appropriate response accurately.

6.3.2b WLQ Research Diary

Phase I happened in July and August, as follows:

July 26, 2018

Company A: We had Wi-Fi connection problems. People came in to help with the questionnaires, but the computers were not connecting. Only managed to complete 10 questionnaires. Attempted hot spots seemed to work. +/- 30 people were unable to reschedule due to holidays the following week.

Company B: Initially had some challenges with second group of questions concerning physical work, that refer to what they can do "without difficulty" … They found this change confusing and frequently had to be explained. The author decided to alert them to the change in questioning and for them to read each section carefully before answering. The author allowed them to scroll back to make corrections if they felt they answered incorrectly. Fortunately, the system allowed for this.

July 31, 2018

Company A: Several unscheduled people came into the company A clinic as a favor to do the questionnaire. They would be going on summer holiday next week thus delaying the project until September. Through internal emails and phone calls, patients were contacted and encouraged to come in and participate today. 32 had scheduled appointments and 11 came in to assist who were scheduled for the 26th of July.

Again, some participants found the change in questioning from "difficult" to "without difficulty" and back to "difficult" confusing. Some had to go back and change their responses accordingly. The system allowed for scrolling up to previous questions to make corrections.

Company B was very busy today. We received assistance from the HR department to encourage participation. Unstable Wi-Fi challenges due to security blockages at this location. Had to resort to Hot Spot, using mobile phone combined with connecting to free Wi-Fi. Was stable most of the time but frustrating as something kept interrupting the process on one of the laptops.

Went very smoothly today. Some interesting comments from participants, were very expressive with body language demonstrating tired, fatigued, exhausted while filling in the questionnaire.

August 2:

Company C: Similar feedback as to the confusion of the questionnaire structure that in the first e section asks…" difficult…" and the second section asks… "without difficulty…", and back to "difficult…"

This appears to be a common theme in all three locations.

Frequently, participants were waiting to fill in the questionnaire, were seated next to the person who was responding to the questions. The author was able to alert people in groups of 4 or 5 people at a time to read each sections' instructions carefully and that the context changes. This sped up the process and decreased confusion. Not sure if this interferes with the scientific process but this is what was done for the sake of transparency.

August 6:

Company C: FEEDBACK: The questionnaire asks how people feel in the morning. Several people n = 32 in the first group (August 2nd) and n = 27 in the second group (August 6th), reported that their pain and ability to concentrate gets worse in the afternoon. Their day starts out relatively "pain free" but after hours of sitting, working or meetings, their symptoms get worse; (neck pain, low back pain, mid back pain, head pain). This was not a question in the WLQ but worthy of noting. The time management section of the questionnaire is orientated as to how people feel and function at the start of their day.

Productivity appears to decrease as the day goes on… It will be interesting to evaluate the responses vs the time of day they responded.

Phase 2 was performed during December 2018 as follows:

December 6th:

Company A began smoothly. The process to complete the questionnaires occurred between 8:00 a.m. to 11:40 a.m. Treatment and control group participants trickled in during the time period as the clinical assistant called each of them to come to the clinic to complete the WLQ. There were no serious challenges and the completion of the questionnaires by the subjects went very quickly. Some subjects did scroll back to the second group of questions as they were phrased differently and again, caused some confusion. This same phenomenon occurred during phase 1.

The Company B group consisted of only the control group on this day due to logistical and technical issues within the clinic and the organization. The process went very smoothly from 12:30 to 14:40 with no major challenges.

December 11th:

Company C: Control group from 9:40 to 12:00 & Treatment group from 12:20 to 14:10. It was a smooth process for the most part, with no major challenges. Patients and control group participants continuously came in during the four-hour period to fill in the questionnaire.

The Company B treatment group questionnaire was completed between 15:10 and 16:50 with no major challenges to speak of.

6.3.2c Absenteeism/Cost Questionnaire:

This phase happened on August 14 and August 16. N = 274 (163 On-Site) (111 Off-Site).

Assistants (employees of the On-Site MSD clinics provider) were asked to complete at least 30 surveys each per day in each location. It required two assistants each day as well as the primary researcher. Some assistants exceeded their goal and others fell short. The Off-Site had fewer participants due to increased challenges attempting to get Off-Site people to participate.

Patients of the On-Site clinics were asked to complete the survey while they were waiting for their consult or treatment, others came to specified locations to participate in the study due to logistical

challenges such as meetings or job responsibilities as well as limited access to the facilities by the research assistants. The research assistants (employees of the On-Site clinic) typically have access only to the On-Site clinics and not to other areas of the companies. Permission from HR was granted for the purposes of completing this academic study allowing them access to employee work break areas, cafeteria, lobby etc. The process typically required less than five minutes of the employee's time and did not interrupt their daily work routine. The absenteeism data collected for the Off-Site subjects was performed at each of the organizations. Subjects were strictly volunteer and selected based on having a self-reported MSD issue in the past year. This was far more challenging since the research assistants were required to recruit participants in the lobby, cafeterias and coffee break stations of the respective locations. Users of the On-Site facilities were instrumental in recruiting their non-clinic-user colleagues to participate in the study via word of mouth promotion thus allowing for a large cluster of willing participants in each location during specified hours and locations. Research assistants used the prompt; "Do you have any Neck or Low Back Pain?" followed by; "Do you have a minute to answer 7 quick and simple questions?" This proved to be highly effective early in the morning and during lunch hours much to the credit of colleague support. It required two days to collect the data sample.

7.0 Results:

7.1 Raw Data Before Scoring for WLQ: Phase 1 and Phase 2, A Brief Summary.

The following is the raw data collected and correlated by the on-line questionnaire provider for the WLQ. It has been transferred into a "Word" format for practicality (Appendix Item 1). It should be noted that, according to the survey provider, 277 people responded to each question for Phase 1 and 191 total questionnaires were completed for Phase 2. An evaluation of the final Excel sheets found some duplications and incorrect patient number entries such as missing or inverted numbers. This was likely human error when patients transferred the numbers from their patient cards into the questionnaire. The final count after errors were removed and omitted, was 258 participants for Phase 1 and 173 for Phase 2, who correctly filled in the questionnaire. The Phase 2 cohort consisted of randomly selected subjects. The *Control group (N = 87)* and the Test Subjects or *Treatment group, (N = 86).* The raw data results were broken down into each of the productivity categories measured using the WLQ and are represented in Figures 7,8,9,10 and 11. Patient file numbers were cross referenced with patient files and survey responses to confirm accuracy prior to calculations. Further cross reference was done using the electronic time, date and the IP address stamps that corresponded with the locations of where the surveys were performed to distinguish the final data between the three companies. There was no way to determine which patients entered their patient numbers incorrectly, thus, incorrect entries were omitted from the study.

7.1.1 WLQ Questionnaire and Raw Data Results:

7.1.1.1 Description of Phase 1 & Phase 2:

The raw, initial data collected by the on-line questionnaire provider, prior to the scoring and scaling process, shed light on some interesting patterns among the employee population. (Appendix Item 3 Contains the raw data results from the Phase- 1 on-line survey provider. In Portuguese only). The raw data for Phase 2 was separated into the "Control" group and the "Treatment" group. Tables were created for each of the 25 questions which include Phase 1 results as well as Phase 2

Control and Treatment groups results. (Appendix Item 4). There were 5 scales used to measure productivity. The first was the *Time Management Scale* with 5 questions, the second was the *Physical Tasks Scale* with 6 questions, the third and fourth were the *Mental and Interpersonal Tasks Scales* with 6 and 3 questions respectively, and the final and fifth was the *Output Tasks Scale* with 5 questions for a total of 25 questions. The response categories as mentioned previously were; difficulty always (100% of the time), difficulty almost always or most of the time (75% of the time), difficulty part of the time (50% of the time), difficult a small part of the time (25% of the time) and finally, not difficult (0% of the time). As a reminder, question 2a-2f, the Physical Tasks scale, is the inverse of questions 1,3,4 and 5, and is framed as "ability to perform…**without** difficulty", again 0%, 25%, 50%, 75% and 100% of the time for each question.

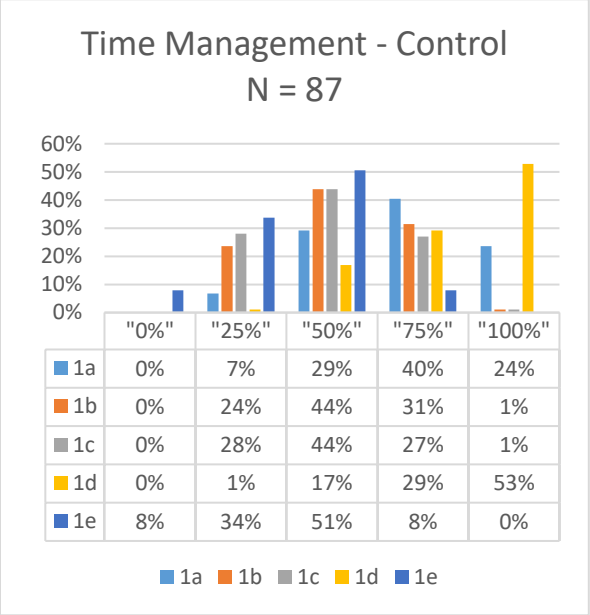
7.1.1.2 Presentation of WLQ Results

The following *Figures* (7, 8, 9, 10 & 11) below, are a combination of graphs and tables which provide a visual perspective of the Phase 2 questionnaire results (December 2018) prior to performing the scaling and scoring process required for obtaining the WLQ Lost Productivity Score. The "Control" group did not receive any treatments between Phase 1 (July, August 2018) and Phase 2 (December 2018). There are 2 graphs for each of the 5 questions. On the left are the Control (no treatments) group results and, on the right, the Treatment group results, each followed by observations and a brief discussion. Immediately below each graph on the "X" axis, are the responses as to what percentage of the work day the subject performed ***with difficulty***, none of the time (0%), a small part of the time (25%), some of the time (50%), almost always (75%) and always (100%), or was able to perform ***without difficulty****(Physical Work Tasks)*, 0%, 25%, 50%, 75% or 100% for each of the questions, a, b, c, d, etc. The "Y" axis represents the percentage of the total sample of subjects (Control Group or Treatment Group) who responded to each of the questions in each of the categories for the sake of graphic presentation. The tables below the "X" axis are the actual percentages of the subjects who responded to each question which corresponds to the "Y" axis.

7.1.1.2a) Time Management

Figure 7 below demonstrates the results of the *Time Management* scale which asked how much time the subjects physical problem made it difficult to; 1a. Work the required number of hours, 1b.

Get going easily in the morning, 1c. Start on your job as soon as you arrived at work, 1d. Do your work without stopping to take breaks or rest, and 1e. Stick to a routine or schedule. The data reveal that most of the Control group (N = 87) experienced difficulties in all categories at least some of the time except for only 8% having no difficulty with sticking to a routine. The greatest challenges appear to be, working the required number of hours and the ability to do work without stopping to take breaks. Still high, but to a lesser degree getting going in the morning and starting their work as soon as they arrived. The Treatment group (N = 86) showed a dramatic shift of improvement in all categories, most remarkably, the ability to work the required number of hours and the ability to work without taking breaks. The majority also appeared to be able to get going more easily in the morning.



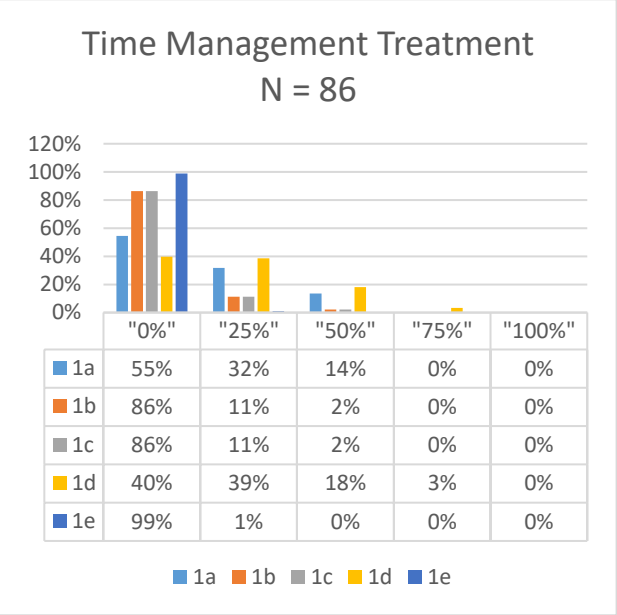


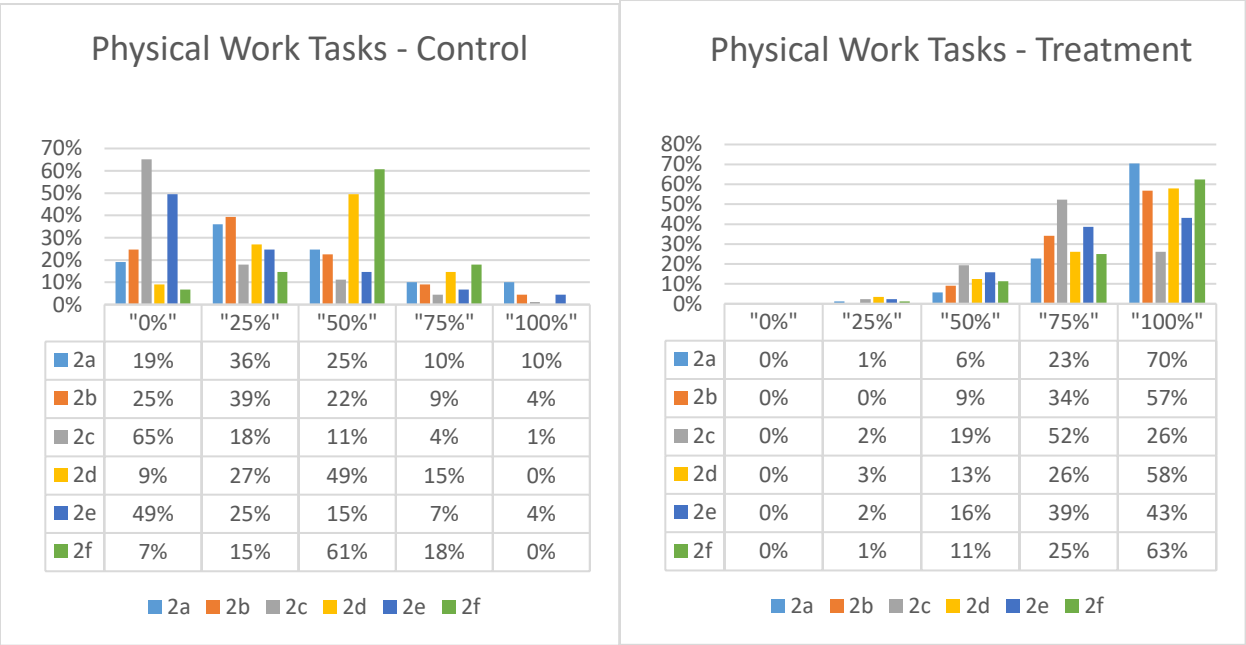
Figure 7 Time Management Scale: Question 1a-1e

7.1.1.2b) Physical Work Tasks

Figure 8 below demonstrates the results of the *Physical Work Tasks* scale which asked about the subjects' ability to handle certain parts of their job ***without*** difficulty. The change in questioning requires some mental gymnastics to follow the opposite logic. 2a. Ability to walk or move around different work locations, i.e.., going to meetings), 2b. Ability to lift 4.5 kilos, 2c. Ability to sit longer than 15 minutes, 2d. Ability to repeat the same motion repeatedly while working, 2e. Ability

to bend, twist or reach for objects, and 2f. Ability to use hand-held tools or equipment (i.e., phone, pen, keyboard, computer mouse etc).

65% of the control population were unable to sit for more than 15 minutes without difficulty, and 49% were unable to bend, twist or reach for objects without difficulty 0% of the time. 61% of the control group were able to use the phone and computer without difficulty for only 50% of the day. A very low percentage of the control group were able to perform all 6 categories of physical tasks 100% of the day. In great contrast, the majority of the Treatment group were capable of performing physical tasks without difficulty for 75% to 100% of the day in all six categories. The ability to move and walk around, the ability to sit longer than 15 minutes at their desk and the ability to do repetitive work, all demonstrated a marked improvement. There was a complete shift to the point that there were no subjects (0%) were unable to perform their tasks and a majority fully capable of performing all tasks for the entire workday.



	"0%"	"25%"	"50%"	"75%"	"100%"
2a	19%	36%	25%	10%	10%
2b	25%	39%	22%	9%	4%
2c	65%	18%	11%	4%	1%
2d	9%	27%	49%	15%	0%
2e	49%	25%	15%	7%	4%
2f	7%	15%	61%	18%	0%

	"0%"	"25%"	"50%"	"75%"	"100%"
2a	0%	1%	6%	23%	70%
2b	0%	0%	9%	34%	57%
2c	0%	2%	19%	52%	26%
2d	0%	3%	13%	26%	58%
2e	0%	2%	16%	39%	43%
2f	0%	1%	11%	25%	63%

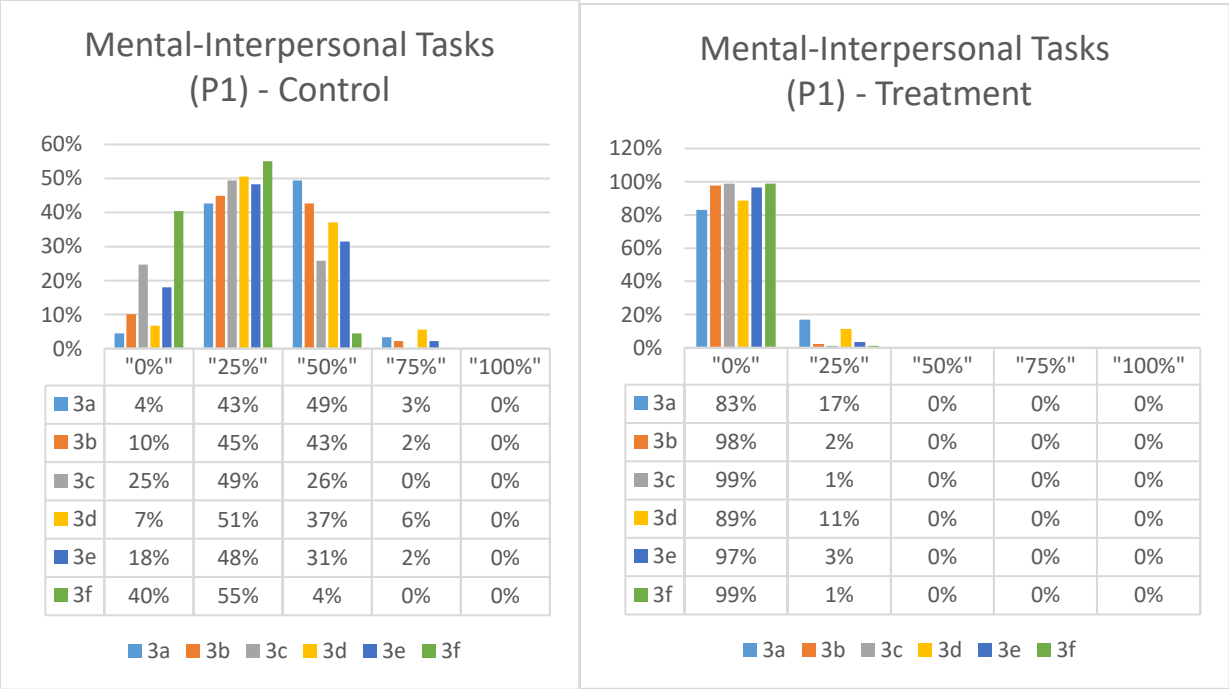
Figure 8 Physical Tasks Scale: Question 2a-2f

7.1.1.2c) Mental-Interpersonal Tasks Part 1

Figure 9 below, demonstrates the *Mental-Interpersonal Tasks* scale questions which revert to the, *with difficulty* for all or part of your day format. The questions categories included; 3a. Keeping

your mind on your work, 3b. Think clearly when working, 3c. Do work carefully, 3d. Concentrate on your work, 3e. Work without losing your train of thought, 3f. Easily reading or using your eyes while working.

Most of the Control group responded to difficulty in all categories for 25%-50% of the work day. More than half of the subjects had difficulty concentrating on their work for at least a small part of the day. None of the control subjects reported having trouble in any of the categories 100% of the work day, and a very small percentage of the group had difficulty almost always. Interesting to note that 95% of the control group only had difficulty for a small part, or not at all, with reading or using their eyes while working. The Treatment group demonstrated a sweeping shift between 83% and 99% of the population *not* having difficulty during their working hours in any of the five categories. Only, "keeping their mind on work" and "concentrating on their work", effected a small percentage of the Treatment group for a small part of the work hours.



	"0%"	"25%"	"50%"	"75%"	"100%"
3a	4%	43%	49%	3%	0%
3b	10%	45%	43%	2%	0%
3c	25%	49%	26%	0%	0%
3d	7%	51%	37%	6%	0%
3e	18%	48%	31%	2%	0%
3f	40%	55%	4%	0%	0%

	"0%"	"25%"	"50%"	"75%"	"100%"
3a	83%	17%	0%	0%	0%
3b	98%	2%	0%	0%	0%
3c	99%	1%	0%	0%	0%
3d	89%	11%	0%	0%	0%
3e	97%	3%	0%	0%	0%
3f	99%	1%	0%	0%	0%

Figure 9 Mental-Interpersonal Tasks Scale, Part 1: Question 3a-3f

Mental-Interpersonal Tasks Scale, Part 2

Figure 10 below, demonstrates the results of Part 2 of the *Mental-Interpersonal Tasks* scale consisted of 3 questions about how the subjects interacted with people during work hours; 4a.

Difficulty in relation to employers, supervisors, coworkers, clients, customers, or the public, 4b. Control your temper around people when working, and 4c. Help other people get work done.

Between 49% and 53% of the Control subjects had difficulty with all three categories at least a small part or some part of their workday. 0% of the Control subjects had difficulty almost always or always. The Treatment group shifted to 94% and 95% of the subjects having difficulty none of the time and between 5% and 6% having difficulty a small part of the time.

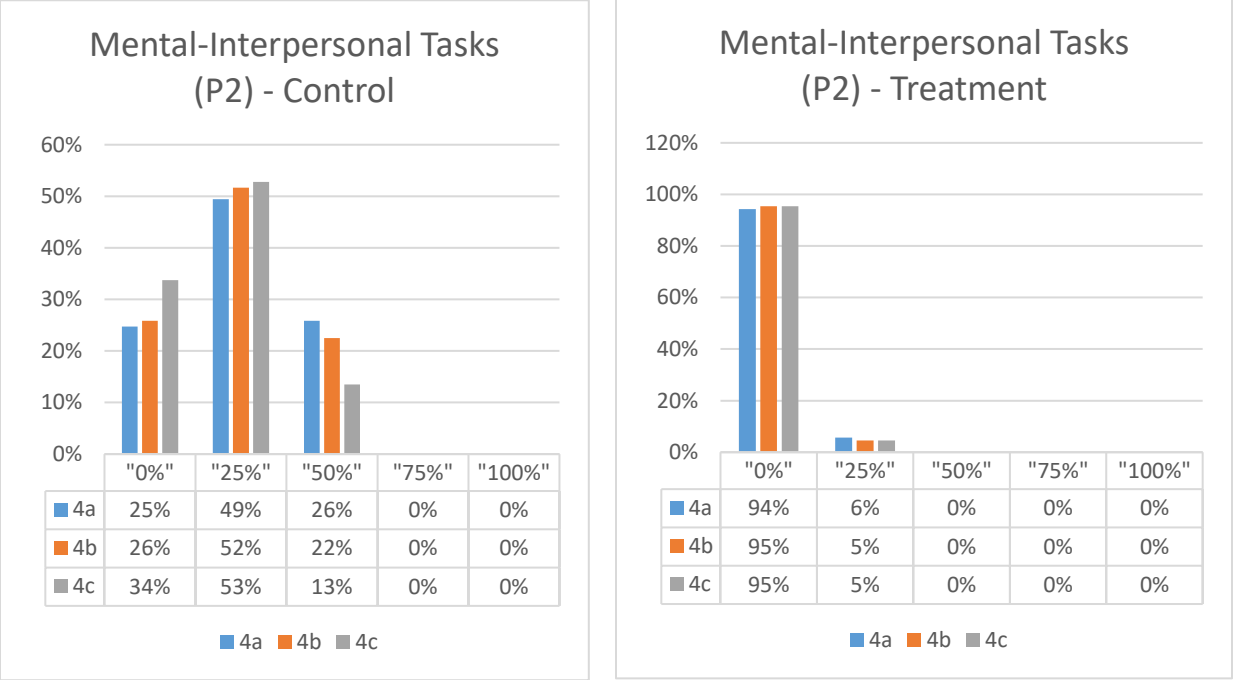


Figure 10 Mental-Interpersonal Tasks, Part 2: Question 4a-4c

7.1.1.2d) Output Tasks

Figure 11 below, demonstrates the results of the *Output Tasks* scale which was intended to learn what percentage of their work day their problem impacted their ability to handled their work overall. The questions were; 5a. To handle their work load, 5b. To work fast enough, 5c.Finish work on time, 5d. Do their work without making mistakes, and 5e. Feel the've done what they are capable of doing.

Between 47% and 48% of the Control group reported that they had difficulty at least half of their work hours in all categories, with the acception of the "making mistakes" category with only 13%. 65% of the subjects reported having difficulty doing their work without making mistakes for a small part of the time and 21% never making mistakes. Between 34% and 40% of the subjects had difficulty almost always, again with the acception of making mistakes, 0% of the subjects. Also, 0% of the subjects expressed having difficulty all of the time in all three categories.

The Treatment group demonstrated a shift of between 66% and 98% of the subjects having difficulty none of the time in all three categories and between 20% and 30% if the subjects a small part of the time. The making mistakes category dropped from 65% to 2% having difficulty a small part of the time. An average of 40% of the Control subjects who responded difficulty at least half of the work day dropped to 3.6%. The almost always difficult responses dropped from an average of 36% of the subjects to 0% of the subjects for all three categores.

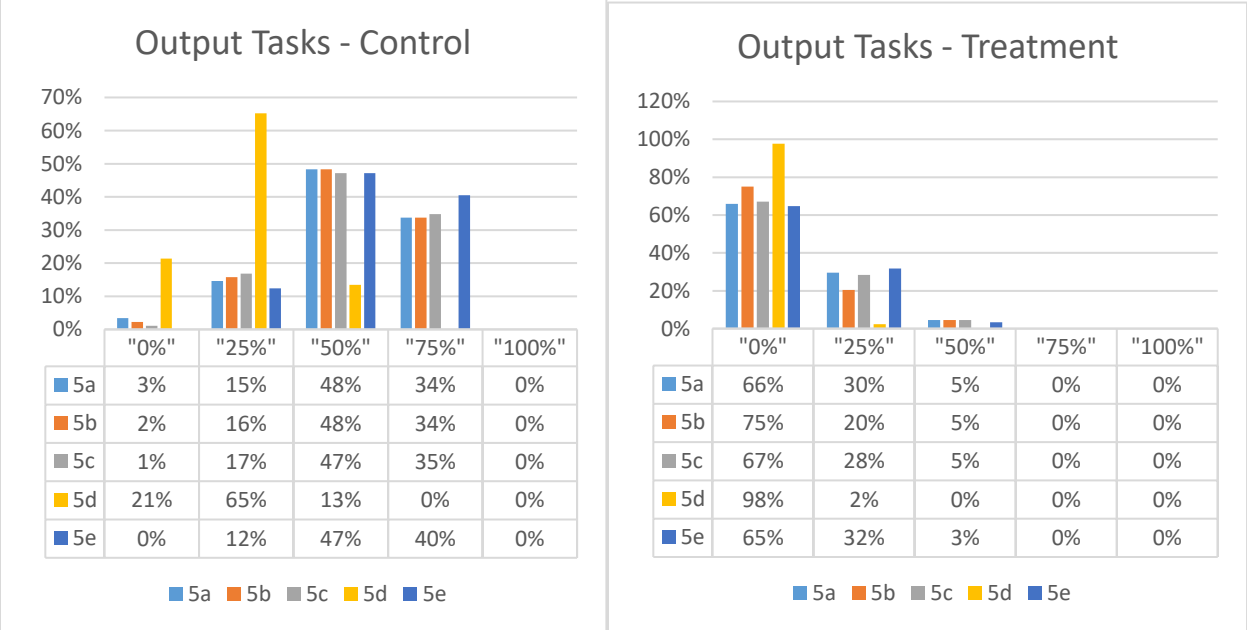


Figure 11 Output Tasks Scale: Question 5a-5e

7.1.1.2e) Summary and reflection

It appears through this evaluation, that employee productivity, as measured by the five categories used for the WLQ, was markedly impacted in a positive way by the treament provided On-Site. Further evaluation, using the scaling and scoring process will provide a lost productivity score (LPS) to determine the average percentage of lost productivity which can later be translated into total average costs.

7.1.2 Results after Scaling and Scoring:

WLQ Scaling and Scoring algorithms were applied to the Excel raw data results sheet. It required several steps and calculations to arrive at a "Productivity Loss" percentage. See attached Scaling and Scoring work sheet (*Annex Item 3*) and explained in the Methods section. The same procedures were followed for both phase 1 and phase 2.

Also merged the clinical data from companies A, B and C to look for further correlations with the WLQ Lost Productivity Score. This was done for both phase 1 and phase 2. The important difference being the existence of the control group for phase 2. The data was taken from the phase 2 subjects (N = 173) and a breakdown of data points of each subject was performed independently to the phase 1 process. The phase 1 results data that was specific to the phase 2 subjects' data were merged based on each participants patient identification number that corresponded with their electronic health records in each clinic. The WLQ scores of the phase 2 participants were compared between the participants phase 1 response and their phase 2 responses, divided into the treatment group and the control group. Thus, there were two WLQ measurements for both groups or four total measurements; Treatment group pre & post and Control group pre & post as shown in *Table 3* and *Table 4* below.

Annual, monthly and hourly wages were calculated using the average wage table for 2017. Average wage was an important hypothesis used to make the calculations possible. To use the actual wages of each employee subject evaluated would be far to complex for the purposes of this study as wages vary greatly between the three organizations. Participants ranged from minimum wage employees to top executives earning very high monthly incomes. Therefore, we decided to use the average *monthly* salary in Portugal in the second half of 2017 which was **€1144.61**, according to data from Trading Economics web site (2018). One year was used as a reference point for monetization because most employers evaluate health and productivity data over a one-

year time frame (Goetzel et al., 2004). All calculations were based on an 8-hour workday (Bureau of Labor Statistics, 2008).

Presenteeism costs were calculated by extrapolating estimates of productivity loss in the past 2 weeks (the WLQ Loss Score) to a 1-year time-period in days, multiplied by total daily compensation (Goetzel et al., 2004).

The WLQ Lost Productivity Scores in Phase 1, demonstrated an average loss of productivity of 10.5% for all three companies evaluated. This satisfies Hypothesis 1; *MSDs increase productivity losses.* Lost Productivity Score Phase differed between companies A:12.81% B8.72% C 10.68% Total Average 10.5%

Table 3 WLQ LPS Phase 1 & 2 by Company

Company	WLQ Phase 1 Treatment	WLQ Phase 2 Treatment	WLQ Phase 1 Control	WLQ Phase 2 Control
A	13.08%	1.20%	13.36%	13.27%
B	7.77%	2.05%	9.75%	9.99%
C	10.88%	2.32%	10.48%	12.93%

Table 4 WLQ LPS Phase 1 & 2 Companies Combined

WLQ-LPS Combined Averages	Treatment: Phase 1	Treatment: Phase 2	Control: Phase 1	Control: Phase 2
Companies A, B,C	10.58%	1.86%	11.20%	12.06%

The Phase 2 results demonstrated a reduction in Total Average Productivity Losses from 10.5% to 1.86%. This satisfies Hypothesis 2; *On-Site MSD treatment Reduces Productivity Losses.*

Though Hypothesis 1 & 2 have been satisfied by the study, there were other variables and possible statistical correlations to be explored for this study, such as; gender, age, cervical spine curves based on x-ray findings, as well as the most common, clinical MSD symptoms, such as; FHP(forward head posture), neck pain, upper extremity pain, mid-back pain, low back pain and lower extremity pain. Included in the main body of this thesis, in the following data section are, the variables of *age* and the clinical finding of *FHP* (forward head posture), based on their

statistical significance. FHP was chosen specifically to be considered as a potential health risk indicator for MSDs, which can be easily observed among most computer-based employee populations. Gender was not found to be a statistically significant variable in relation to the WLQ lost productivity score, nonetheless the results can be found in the statistical tables. Every clinical symptom listed above which was associated with MSD, demonstrated a very high statistical significance in relation to the WLQ lost productivity score. Such specificity, in the context of statistical and correlational evaluation of the symptomatic data, is beyond the scope of the hypotheses set forth in Section 2, nonetheless, the results of the data evaluation are available in the statistical evaluation section for the convenience of the reader. Such findings are useful for future studies with a more clinical leaning.

7.1.3 Sample Average Age and WLQ LPS

Table 5 below represents the average ages of each of the three employee populations evaluated for this study as well as the relative percentage of lost productivity for each based on their lost productivity score (LPS).

Table 5 Average Age & WLQ LPS Comparison

Company	Average Age	WLQ LPS
A	54	12.81%
B	35	8.72%
C	47	10.68%

Table 6 below breaks down the age groups across the total sample set providing an average LPS percentage for different age ranges.

Table 6 Age & WLQ LPS Comparison

Age Range	WLQ LPS
24-34	9.33%
35-44	9.60%
45-54	10.87%
55+	11.56%

Figure 12 below, represents the relationship between increased age and increased WLQ LPS with associated costs, statistical evaluation revealed a significant correlation.

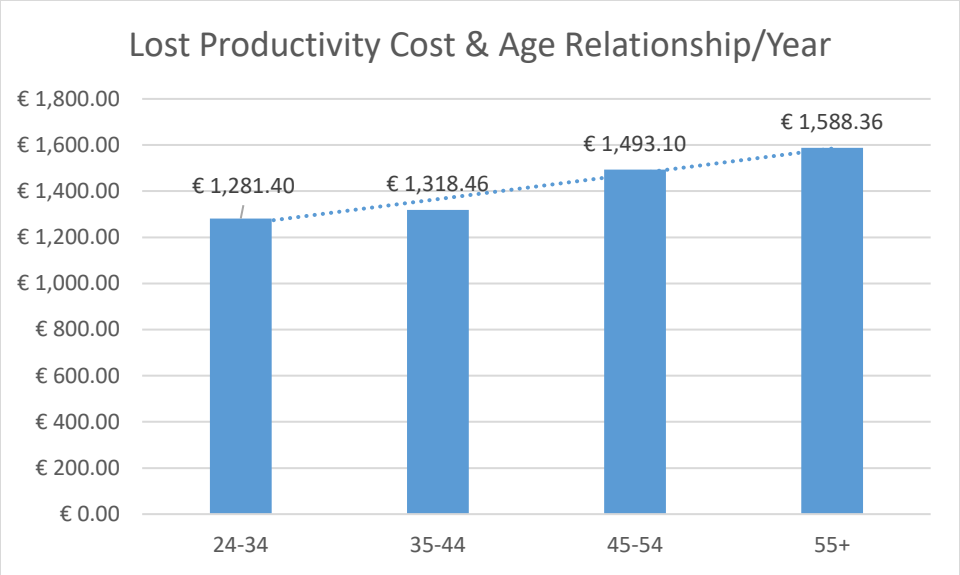


Figure 12 Lost Productivity Cost/WLQ % & Age Relationship/ Year

7.1.4 Cost of Lost Productivity Per Case, Per Year in Portugal:

Conversion of WLQ score to Euros, based on average Portuguese wages 2017.

Table 7 below represents lost productivity costs calculations by extrapolating estimates of productivity loss in the past 2 weeks (the WLQ Lost Productivity Score) for each company respectively and multiplying that number by the average annual compensation of €13,735.32 to give the annual cost of lost productivity per case. The cos of lost productivity calculations for each of the companies studied are represented in *Table 7* below.

Table 7 Cost of Lost Productivity by Company

Company	WLQ Score	WLQ X Average Compensation	Lost Productivity Cost per Person Per Year:
A	12.81%	12.81% x €13,735.32	€1,759.33
B	8.72%	8.72% x €13,735.32	€1,197.17
C	10.68%	10.68% x €13,735.32	€1,467.37

The same formula was applied to the Phase 2 WLQ results to arrive at the cost figures. It is important to notice and remember that the Phase 1 WLQ numbers are slightly different within the studies Phase 2 calculations due to the smaller representative sample of Phase 2 of this study.

Again, for the sake of clarity, rather than show the four categories of the three companies individually, *Table 8* and *Figure 13* represent the average total cost of lost productivity of the three

companies combined in the context of the; Treatment group, Phases 1 & 2, and the Control group, Phases 1 & 2.

Table 8 Cost of Lost Productivity. Study Group vs. Control Group

16-18 Week time frame between Phase 1 and Phase 2	WLQ LPS Total Average	Annual Compensation	Lost Productivity Cost per Person Per Year:	Calculation of Change Phase 1 – Phase 2	Net Savings or Loss Per Person Per Year:	
Treatment Phase 1	10.58%	x €13,735.32	€1,453.20	1,453.20 -255.49 =		
Treatment Phase 2	1.86%	x €13,735.32	€255.49		**€1,197.71 Savings**	
Control Phase 1	11.20%	x €13,735.32	€1,538.35	1,538.35 – 1,656.48 =		
Control Phase 2	12.06%	x €13,735.32	€1,656.48		**-€118.13 Loss**	**Additional loss**

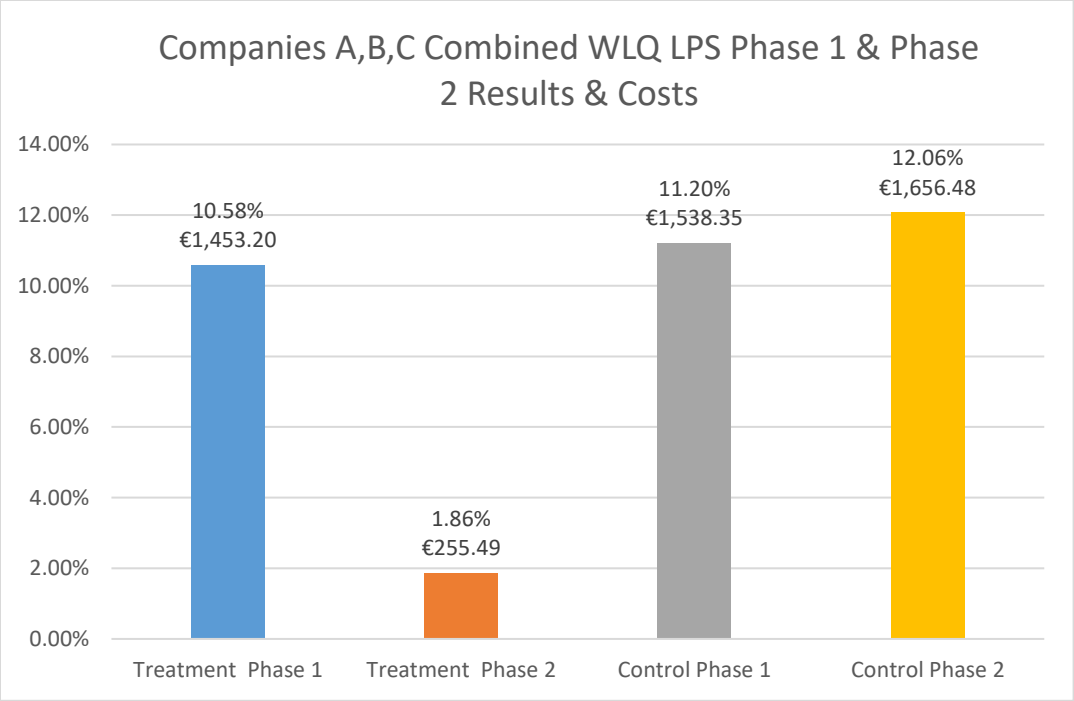


Figure 13 WLQ LPS Phase 1 & 2, Companies A, B, C Combined with Associated Costs

7.1.5 Cost of Lost Productivity Per Case, Per Year in the U.S.A.:

For the sake of discussion, considering that the U.S. employers are burdened with health care costs and appear to give little attention to productivity losses, or to MSDs in the workplace, calculations were performed as follows:

Conversion of WLQ score in U.S. Dollars was based on average wages in the United States 2017 using the same method for the Portuguese calculations. As mentioned previously, the U.S. employers carry nearly 100% of the burden of health care costs for their employees. As such, U.S. employers are looking for strategies to reduce, primarily, direct health care costs. This section of the study demonstrates additional potential savings for U.S. organizations by evaluating the indirect costs of productivity.

Average Salary Information for US Workers. According to the Bureau of Labour Statistics (BLS), the median wage for workers in the United States in the fourth quarter of 2017 was *$857 per week; $3,428 per month and $44,564* per year for a 40-hour workweek. ... However, salaries can vary

significantly based on both occupation and location. This translates to $3,428 per month which was applied to the formula. Average Lost Productivity Cost per Year per Case in the U.S. were $6,967.50

White-collar workers usually earn a salary. For example, the median annual wage for lawyers as of May 2017 was $141,890 according to the Bureau of Labour Statistics. The median wage for financial managers was $121,750, while the median wage for doctors was $208,000 (The Balance, 2018). Average White-Collar Wage in the U.S. was $13,101 per month, which calculated to: an average Lost Productivity Cost per Year per Case of $26,628.14.

Figure 14 below demonstrates the average cost of lost productivity per year based on the WLP LPS of Company A, B & C respectively, in U.S. Dollars, which is based on average annual wages for U.S. employees.

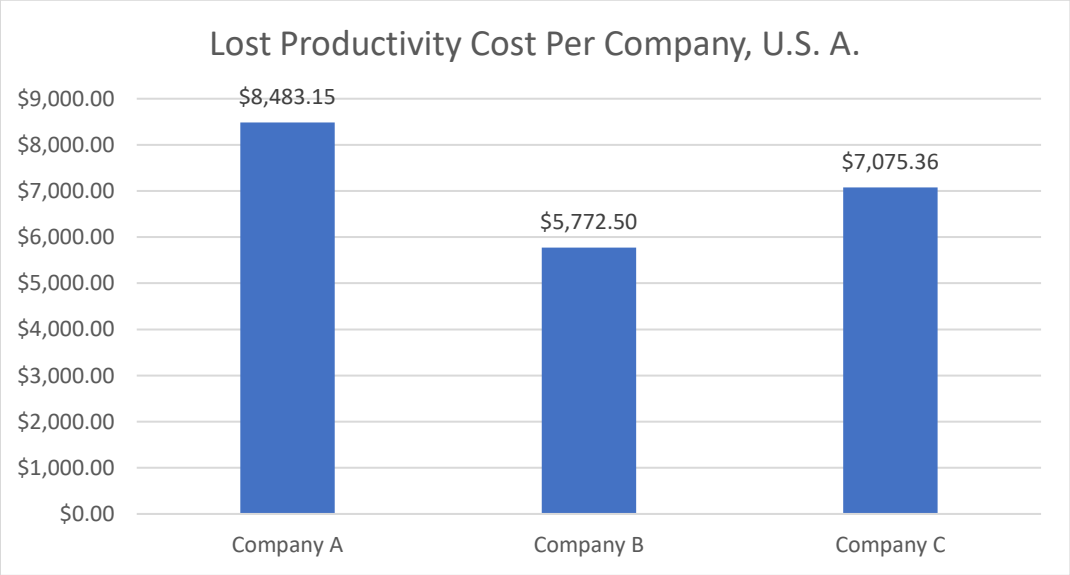


Figure 14 Lost Productivity Cost Per Year/Company, U.S.A.

7.2 Results: Raw Data for Absenteeism & Cost analysis:

As for the WLQ, the correlated data was provided by the questionnaire service provider and put into "Word" format by the author with the English translation for each question in parentheses below the original question. The results were provided in a "read only" format and could not be copied directly. Patient file numbers were not included as a data point for this survey because Off-Site was also being questioned. (Appendix Item # 6)

7.2.1 Results: Absenteeism Raw Data

1. É paciente da clínica On-Site? (recebe tratamentos na clínica do seu local trabalho)

   (Are you a patient of the On-Site clinic?)

   274 de 274 pessoas responderam esta pergunta (274 of 274 people responded to the question)

   - Sim (Yes) 163 / 59%
   - Não (No) 111 / 41%

2. No último ano, quantas vezes foi obrigado a ausentar do seu trabalho devido às condições musculoesqueléticas tais como dores lombares, dores cervicais, etc.?

   (In the past year, how often was it necessary to miss work due to musculoskeletal conditions such as low back pain or neck pain?)

   274 de 274 pessoas responderam esta pergunta

   - 0 dias (days) 126 / 46%
   - 1-2 dias 85 / 31%
   - 3-5 dias 33 / 12%
   - 6-10 dias 13 / 5%
   - mais de 16 dias 11 / 4%
   - 11-15 dias 6 / 2%

3. No último ano, quantas horas teve de ausentar do trabalho por cada consulta/tratamento (em média)? (In the past year, how many hours of work did you miss for consults/treatments (on average)?)

   274 de 274 pessoas responderam esta pergunta

   - 0 a 1 horas por consulta (hours per consult) 160 / 58%
   - 1 a 3 horas por consulta 106 / 39%
   - 3 a 5 horas por consulta 8 / 3%
   - mais de 6 horas por consulta 0 / 0%

4. No último ano, quais os médicos/especialistas que teve de consultar fora do local de trabalho para diagnosticar e tratar a sua condição musculoesquelética (tais como dores lombares, dores cervicais, etc.)? (In the past year, which doctors or specialists did you consult with

outside of work to diagnose or treat your musculoskeletal condition (such as low back pain, neck pain etc.)?)

274 de 274 pessoas responderam esta pergunta

- Nenhum (None) 118 / 43%
- Médico de Família (Family Doctor) 112 / 41%
- Fisioterapeuta (Physical Therapist) 82 / 30%
- Cirurgião Ortopédico (Orthopedic Surgeon) 41 / 15%
- Fisiatra (Phsyiatrist) 37 / 14%
- Neurocirurgião (Neurosurgeon) 34 / 12%

5. No último ano, pense na sua mais recente condição musculoequelética (tais como dores lombares, dores cervicais, etc.). Quantos dias passaram entre os primeiros sintomas e o início do tratamento efetivo da condição? (In the past year, think of the most recent musculoskeletal conditions (such as low back pain, neck pain, etc.). How many days lapsed from the onset of symptoms to the start of treatment for your condition?)

   274 de 274 pessoas responderam esta pergunta

   - 1 a 6 dias (days) 179 / 65%
   - 15 a 21 dias 39 / 14%
   - 7 a 14 dias 39 / 14%
   - mais de 22 dias 17 / 6%

6. No último ano, quais os exames de diagnóstico teve de fazer para diagnosticar e tratar a sua condição musculoesquelética (tais como dores lombares, dores cervicais, etc.)? (In the past year, which of the following diagnostic exams did you have to do to diagnose and treat your musculoskeletal condition (such as low back pain, neck pain, etc.?))

   274 de 274 pessoas responderam esta pergunta

   - Nenhum (None) 139 / 51%
   - Raio-X (X-Ray) 121 / 44%
   - MRI (Ressonância Magnética) 45 / 16%
   - TAC (Tomografia Axial Computorizada) (CT) 42 / 15%

- EMG (Electromiograma) (Electromyogram) 28 / 10%

Absenteeism costs were estimated using the "lost wages method," the most frequently used method to measure the cost of productivity loss (Nicholson et al., 2006). To derive the cost of work loss attributable to absenteeism in the past year, the total number of workdays lost was multiplied by the average daily compensation for full-time employees. In addition, an average wage "multiplier" of 1.61, where the multiplier is defined as the cost to an employer of an absence as a proportion of the absent worker's daily wage was used for calculating the *U.S. comparison (Nicholson et al., 2006).*

Annual, monthly and hourly wages were calculated using an average wage table for 2017. The average salary in Portugal in the second half of 2017 was **€1,144.61**, according to data from Trading Economics web site (2018). It is worth noting that according to a 2016 report by the Gabinete De Estratégia e Planeamento, employees in the energy, financial services and insurance sectors, typically get higher than Portugal's average income (GEP, 2016). The average wages for energy, banking and consulting employees were not used for this study because of the wide age range and years of employment among the study population.

A continuous variable was used by recoding response options to indicate total work-days lost per year because of absenteeism (e.g., "1–2 days" can be recoded as 1.5 days, "3–5 days" can be recoded as 4 days etc.) (Goetzel et al., 2004; Mitchel & Bates, 2011). We can use the same variables to calculate each question.

7.2.2 Absenteeism: from Disability, Consults, Treatment and Diagnostics

A cursory glance at the initial data shows an obvious difference in the absenteeism rates between employees who use the On-Site MSD clinic and those who sought Off-Site consults, treatment and diagnostic imagery such as X Ray, MRI, CT and EMG.

Each question was prompted with; "In the past year…"

Breaking the data into the individual categories revealed the relative absenteeism totals, thus exposing which of the categories contributed to the greatest absenteeism rates.

The first category, absenteeism caused by *disability*, meaning they could not or did not go to work that day, was measured in days and converted to 8 working hours per day to be consistent with the other categories. Following the methods used by other researchers (Goetzel et al., 2004; Mitchel & Bates, 2011) a continuous variable was used by recording response options to indicate total *work days* lost per year due to disability associated with their MSD (e.g., "0" days, "1-2" days was recorded as 1.5 days, "3-5" days was recorded as 4 days etc.). Days were converted into 8 hours per day to arrive at total hours missed per case per year.

The categories; absence for treatment, medical consults and diagnostics were calculated based on the response to the question, "…on average, how much time do you spend away from work to be treated…", or "…for consults…" Following the same logic used for days, a continuous variable was used by recording response options to indicate the total *work hours* lost per year per treatment, consult or exam (e.g., "0-1" hours, was recorded as .5, "1-2" hours was recorded as 1.5 hours, "3-5" hours was recorded as 4 hours etc.). The assumption was made to use the average hours results per treatment, consults and diagnostics as being the same, and applied them to the calculations (e.g., if the average time spent per external(Off-Site) consult response was "2.12" hours, 2.12 was used as the hourly multiplier times the number of Off-Site treatments, consults or diagnostics per subject per year).

For the category "absence for treatment", the average time per treatment was multiplied by a factor of 8 for the On-Site clinic and 20 for the Off-Site interventions, under the assumption that the average number of treatments per person was 8 and 20 per year respectively. This is consistent with treatment averages for physical therapy performed within developed Western countries including the Portuguese health system as well as the On-Site treatment averages for various low back and neck issues taken from the electronic health records within the three MSD clinics (Skargren et al., 1998, Clair et al., 2006; Haas et al., 2014; Hatch, 2018).

Table 9 below demonstrates the total number of hours of MSD related absenteeism based on subject responses to the questionnaire in the following categories; disability, treatment, medical consults and diagnostics. All categories were totaled, and a comparison made between On-Site and Off-Site.

Table 9 Total Absenteeism Hours Per Case (by category): On-Site vs Off-Site

Category:	**Disability**	**Treatment**	**Medical Consult**	**Diagnostics**	**Total Absence**
On-Site:	4.88	10.2	0.82	0.89	16.62
Off-Site:	37.33	24.35	4.00	2.70	68.38

Figure 15 below is simply a graphic display of the data in *Table 9* above to add a visual and relative perspective to the findings.

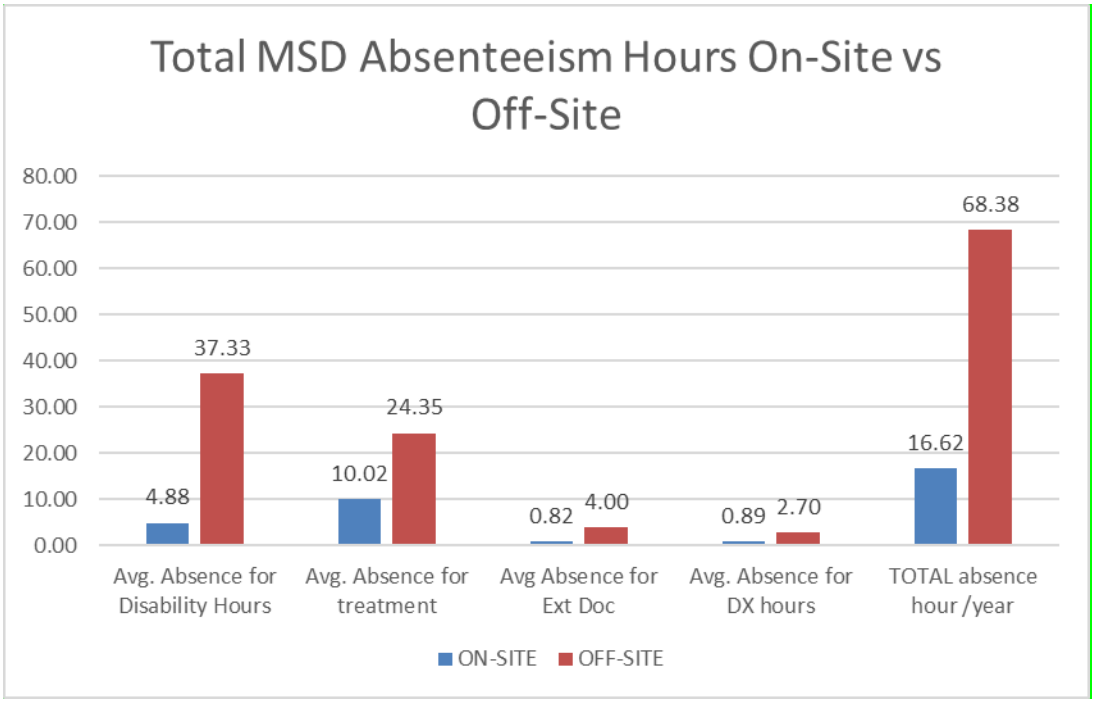


Figure 15 Total Absenteeism Hours Per Case (by category): On-Site vs Off-Site

Table 10 below are the calculations used to determine the total absenteeism hours, associated with the following categories; disability, treatments, medical consults and diagnostic consults based on the responses to the questionnaire. This table represents the mathematical process applied to the calculations found in *Table 9* and *Figure 15* above. Each cell explains the calculations used.

Table 10 Calculations: Average Absenteeism by Category Per Case Per Year

	On-Site	Off-Site
Disability: Average Absence/ Hours per Year	0.6(average # of days missed in the year) X 8 hours = **4.88**	4.67(average # of days missed in the year) X 8 hours = **37.36 hours**
Treatment: Average Absence/ Hours per Year	0.7(average time in hours for On-Site treatment(Q3)) X 8(average # of On-Site treatments/year) = 5.6(average hrs missed per year for On-Site treatment) + 1.89(average time in hours for Off-Site treatment(Q3)) X 20(average # of treatments Off-Site/year) X 11% (19 of On-Site population (n=163); 19/163= .11656) who received treatments Off-Site(Q4)) = 9.758 5.6 + 4.4 = **(10.2) Excel rounded up.**	1.89(average time in hours for Off-Site treatment(Q3)) X 20(average # of treatments Off-Site/year) = **37.8**
Medical Consults: Average Absence/ Hours Year	1.89(average time in hours for Off-Site treatment(Q3)) X 0.4355(average # external consults of On-Site population) = **0.82**	1.89(average time in hours for Off-Site treatment(Q3)) X 2.117 (average # of external consults of Off-Site population) = **4.0**
Diagnostics: Average Absence / Hours Year	1.89(average time in hours for Off-Site treatment(Q3)) X 0.472 (average external diagnostics of On-Site population) = **0.89**	1.89(average time in hours for Off-Site treatment(Q3)) X 1.43(average # external diagnostics of Off-Site population) = **2.70**

The "Treatment" variable required further calculations compared to the other variables. On-Site treatment for neck, low back and extremity pain required on average 8 treatments per person per year. The number of Off-Site treatments, performed by physical therapists, on average, was 20

treatments. Of the On-Site group, 11% of the subjects underwent Off-Site physical therapy interventions for musculoskeletal conditions that required more complex clinical treatment than the On-Site clinical model could provide. The On-Site average treatment time was 0.7 hours based on Q3, multiplied by a factor of 8 (average number of treatments, based on review of patient clinical data). Then, taking the calculation for Off-Site treatment time based on Q3 (average time for external consults) of 1.89 hours, multiplied by a factor of 20 (based on average physical therapy treatments) and then multiplied by 11%(percentage of the On-Site population who did Off-Site physical therapy(19 out of 163), the total average hours for Off-Site treatment by the On-Site group were added to the On-Site total average to arrive at 10.2 hours of treatment related absenteeism per person per year.

7.2.3 Absenteeism Costs in Euros, Per Person Per Year: Portuguese Wages.

Total Absenteeism Cost of Lost Wages Per Person, Per Year: On-Site vs Off-Site. (All Categories). As explained previously, it was important for the hypotheses concerning costs that we used an average wage formula, fully aware that the wages among the study subjects ranged greatly.

Formula: Average Monthly Wage for Portugal: €1,144.61 / 22 Working Days

Average Daily Wage: = €52.03 / 8 hrs. per Day

Average Hourly Wage: = €6.50

Average Hourly Wage: €6.50 X Average Total Hours Absent Per Year (On-Site or Off-Site; All Categories) = Average Cost Per Person, Per Year.

Table 11 below demonstrates the final calculations for the On-Site and the Off-Site comparison to determine the total cost per person per year for MSD related absenteeism.

Table 11 Cost Calculations: Total MSD Related Absenteeism On-Site vs. Off-Site

	Av. Hourly Wage	Av. Total Hours Absent Per-Person, Per-Year	Av. Total Cost Per-Person, Per-Year
On-Site	€6.50 X	16.62	= €108.03
Off-Site	€6.50 X	68.38	= €444.47

Figure 16 below demonstrates how much MSD related absenteeism cost per person per year comparing the On-Site group with the Off-Site group using the calculations mentioned above.

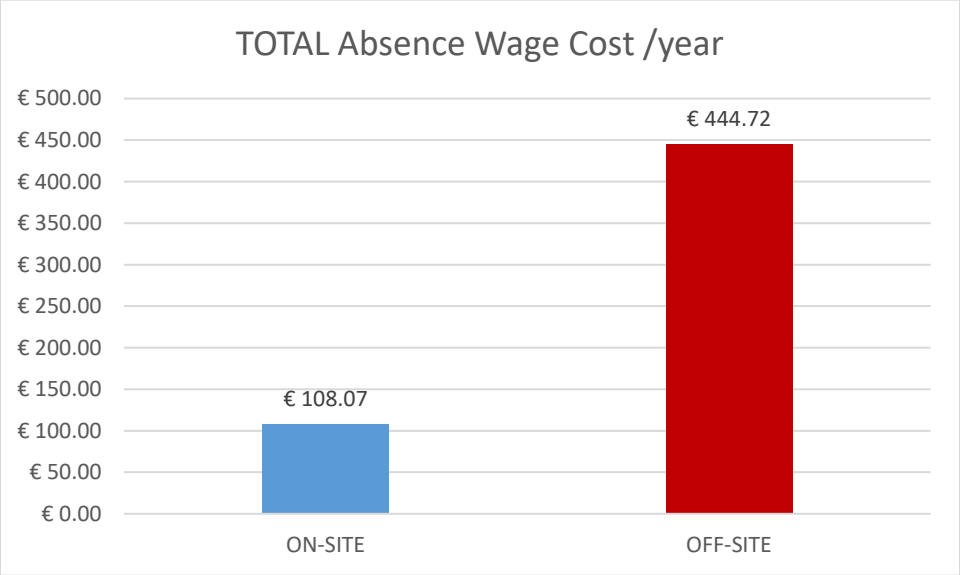


Figure 16 Total Absence Cost, Disability & Consults per Year

7.2.4 Average Absence Cost for All Consults Per Person Per Year: (Excluding Disability)

Table 12 below shows the calculations and *Figure 17* below show the Average Absence Cost For all Consults Per Person Per Year: On Site vs Off-Site (Excluding Disability)

Table 12 Cost of Absenteeism less Disability

	Av. Hourly Wage	Av. Total Hours Absent Per-Person, Per-Year	Av. Total Cost Per-Person, Per-Year
On-Site	€6.50 X	11.73	= € 76.245
Off-Site	€6.50 X	31.05	= €201.825

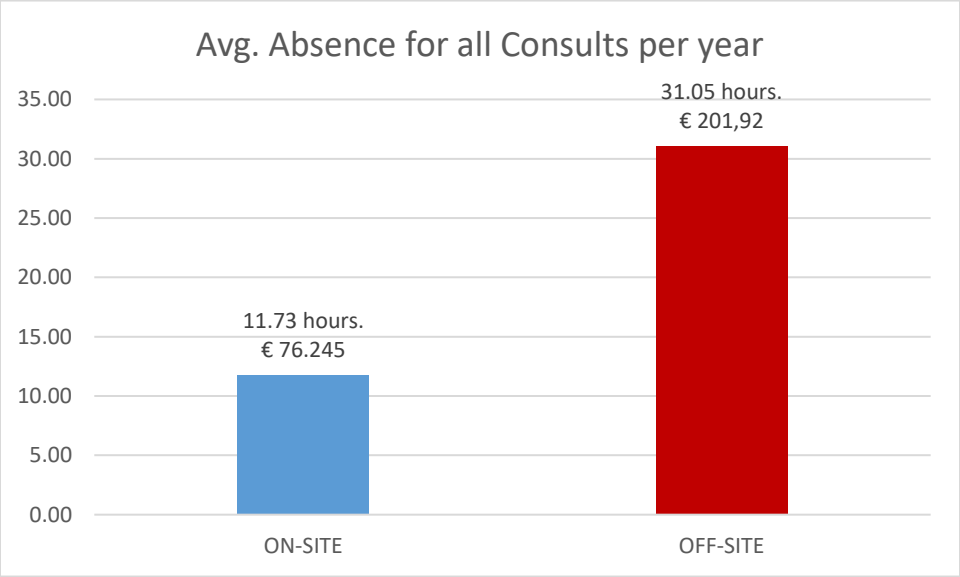


Figure 17 Absence Cost for All Consults per Year, excluding Disability.

7.2.5 Days from Onset of Symptoms to First Day of Treatment:

It is worth noting that there was a significant waiting time difference between the On-Site and Off-Site groups from the time of symptom onset to the time of first treatment of 3.6 working-days and 14.09 working-days respectively as demonstrated in *Table 13* and *Figure 18* below. Though this variable may not determine absenteeism hours, it does demonstrate that employees in need of treatment must wait, on average, four times longer if they do not have access to an On-Site MSD treatment clinic.

Table 13 Average # of Work-Days/Hours from Symptom Onset to First Treatment

	On-Site	**Off-Site**
Average # of Days from Symptom Onset to First Treatment:	3.6 days	14.09 days
Days Converted to Hours = Average # of Work Hours	3.6 Average Work-Days x 8 Hours Per Work-day = 28.8 Work-Hours	14.09 Average Work-Days x 8 Hours Per Work-day = 119.2 Work-Hours

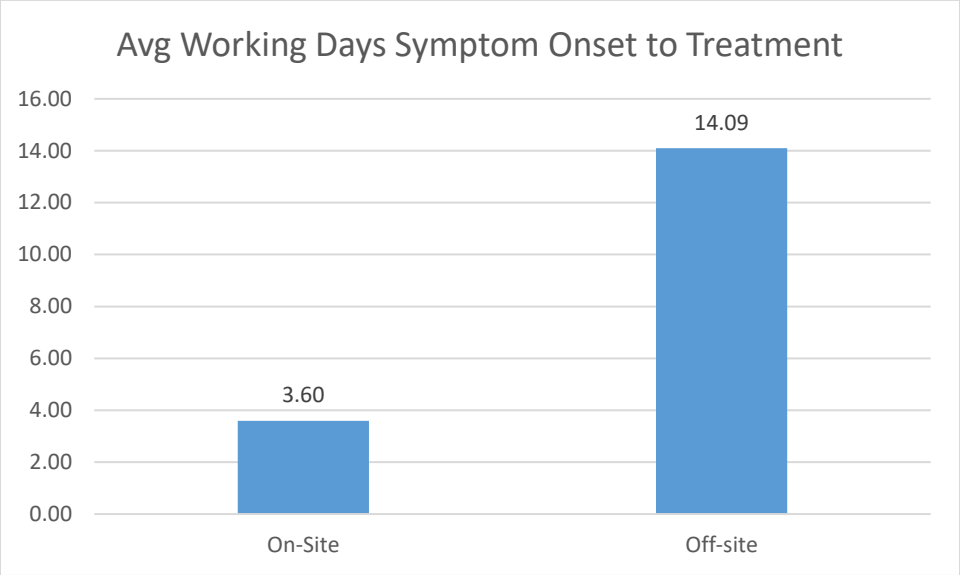


Figure 18 Average Working Days from Symptom Onset to First Treatment

This finding is significant, in that, employees who don't have access to On-Site treatment, must suffer longer with their MSD pain or other symptoms. Thus, costing the organization more in productivity losses, as determined by the WLQ lost productivity score, for a longer period. This finding is not a factor of absenteeism, as are all the other variables in the absenteeism study, but the WLQ instrument used to measure lost productivity, did not allow for a time measurement of symptom onset and clinical intervention, which was quite a significant metric in several other studies (Fit For Work Europe, 2013).

7.3 Results of Econometric Calculations:

7.3.1 WLQ Statistical econometric outputs:

The purpose of this study was to determine if there was in fact a significant statistical correlation between work related MSD and productivity losses using the results from the WLQ LPS (Work Loss Questionnaire, Lost Productivity Score). The most common MSDs encountered in the On-Site clinical setting were; Forward Head Posture (FHP), Neck Pain, Upper Extremity Pain, Mid

Back Pain, Low Back Pain, and Lower Extremity Pain. Additional factors/variables evaluated were Age, Gender and Cervical Spine Curvature.

Subjects were evaluated for the following clinical symptoms:

1. **FHP** (Forward Head Posture): A common postural distortion among computer users. Used interchangeably in the body of the paper with FHC (Forward Head Carriage).
2. **Neck Pain:** From behind the base of the skull to the posterior aspects of the neck muscles to shoulder level.
3. **Upper Extremity Pain:** Included the shoulders, elbows and wrists or entire arm.
4. **Mid Back Pain:** From the base of the skull to between the shoulder blades.
5. **Low Back:** Waist level to sacrum level back pain.
6. **Lower Extremity Pain:** Including hip, knee, ankle and general leg pain such as sciatica.
7. **X-Ray Findings:** Evaluation of "Normal" and "Abnormal" cervical spine curvatures. Of clinical interest. Only 4.85% presented with Normal vs 95.15% with Abnormal Cervical Curve.

Though the hypotheses concerning MSD and productivity losses have been clearly satisfied, we felt, due to a large amount of clinical data available on each patient, that said data may be used to discover correlations as well as learn which of the clinical symptoms or findings has the greatest impact on lost productivity. Such discoveries can potentially serve as predictors to productivity losses and preventive measures can be taken before losses occur. Therefore, it was decided to perform statistical analysis using IBM SPSS software on the 7 categories mentioned above.

The analysis was made in four steps.

We began to analyze using the Pearson's correlation. The results are shown in *Table 14* below. No correlation that was found to be significant at 0.1 or less and be higher than .5 in absolute value, a fact that implies that the data do not have multicollinearity.

Table 14 WLQ: Pearson's Correlations & Clinical Presentation

N = 260	WLQ Prod. Loss Score	Gender	FHP	Neck Pain	Upper Extrem Pain	Mid Back Pain	Low Back Pain	Lower Extrem Pain	X Ray Finding	Age
WLQ Prod. Loss Score	1									
FHP	.228***	.142**	1							

	.000	.022								
Neck Pain	.409*** .000	-.171*** .006	-.013 .833	1						
Upper Extremity Pain	.368*** .000	-.194*** .002	.024 .700	.299*** .000	1					
Mid Back Pain	.158** .011	-.086 .169	-.092 .138	.065 .297	.073 .238	1				
Low Back Pain	.385*** .000	.037 .549	.142** .022	.023 .714	.017 .781	-139** .025	1			
Lower Extremity Pain	.194*** .002	-.078 .211	.058 .354	-.058 .352	.003 .961	-.076 .224	.269*** .000	1		
X Ray Findings	.351*** .000	-.131** .035	.195*** .002	.213*** .001	.129** .037	.056 .366	.083 .185	.114* .066	1	
Age	.319*** .000	-.010 .876	.221*** .000	.049 .427	.155** .012	-.100 .106	.124** .045	.236*** .000	.499*** .000	1

Note: *** Correlation is significant at the 0.01 level (2-tailed) **Correlation is significant at the 0.05 level (2-tailed) `* Correlation is significant at the 0.1 level (2-tailed).

Secondly, we performed simple linear regressions, and the results are shown in *Table 15* below. All the variables showed a strong relation with WLQ-LPS, the highest being with Age, FHP, Neck Pain, Upper Extremity Pain and Low Back Pain (with p significances lower than 0.01) followed by Mid Back Pain and Lower Extremity Pain, (less than 0.05). In terms of coefficients, the highest were found to be related to Neck Pain, followed by Low Back Pain, Upper Extremity Pain and finally FHP. An increase in one unit in any one of those variables results in a productivity loss of more than 3 percent (3%) in organizations. These findings are important in policy terms, as we will discuss later (See Discussion).

Table 15 Simple linear regressions on WLQ LPS

Independent Variable	**Adjusted R2**	**B**	**Sig**
Age	0.098	0.001	0.000
Gender	0.009	-0.009	0.067
FHP	0.048	0.023	0.000
Neck Pain	0.164	0.037	0.000
Upper Extremity Pain	0.132	0.030	0.000
Mid Back Pain	0.021	0.014	0.011
Low Back Pain	0.145	0.034	0.000
Lower Extremity Back Pain	0.034	0.015	0.002
N = 260			

Note: The WLQ Lost Productivity Score (LPS) represents the Dependent variable in the analyses of each category.

Third, we performed a multiple regression whose results are shown in *Table 16* below. So, all seven variables explain nearly 48 percent of total WLQ variation. More than that, five variables have very significant coefficients and of those, Low Back Pain had the highest impact in WLQ LPS score, of 3 percent per unit, Neck Pain has 2.7 percent, and Upper Extremity Pain of 1.8 percent.

Table 16 WLQ - Multiple Regressions

Independent Variables	B	Significance
Age	0.010	0.09
FHP	0.014	0.03
Neck Pain	0.027	0.00
Upper Extremity Pain	0.018	0.00
Mid Back Pain	0.017	0.00
Low Back Pain	0.030	0.00
Lower Extremity Pain	0.006	0.99
N = 259		
R2 Adjusted = 0.476	Explains 48 percent of total variation of WLQ	
F value = 27.174, sig = 0.00	Significance total	

The final sample size for the study was: N = 258. Sex Distribution was: 51% Female, (N = 133) and 49% Male, (N = 127). The average age of the cohort was 44 years. The average WLQ Lost Productivity Score (LPS) across the three companies was 10.5%. It is interesting to note that the LPS was in fact impacted by the variables of age, gender and quite possibly industry, thus leaving the door open for future studies. As the LPS changed, so did the ultimate cost to the organization.

The average LPS for males was 10% and for females, 11%. Not found to be statistically significant when evaluated.

Clinical Correlations:

Clinical correlations by symptoms were pulled from the data to test the LPS results. The absolute average of all symptoms was 10.52%, the same as the population in general. Out of curiosity, it was interesting to learn which of the symptoms individually resulted in a higher LPS as well as which symptoms in combination resulted in the highest LPS. This was done to shed light on potential risk factors that could possibly be helpful in focusing resources accordingly to prevent and or correct the cause of the symptoms. The formula was applied to each patient with the corresponding symptoms.

FHP (Forward Head Posture) is when the ears of the patient are anterior, relative to their shoulders when they should be aligned on the vertical axis. The LPS for each of the pain symptoms evaluated is as follows: FHP: 11%, Neck Pain: 11.5%, Upper Extremity Pain: 12%, Mid Back Pain: 11.5%, Low Back Pain: 11.5% and Lower Extremity Pain: 11.3%. The highest combination was Mid Back & Low Back Pain at 13%. All combinations in pairs of two symptoms ranged from 12% to 13%. The few patients who had the unfortunate circumstance of experiencing all symptoms was 16.42% LPS on average. There were a surprising number of people in this range. The lowest LPS in the group was 1.4% and the highest was 21%.

Cervical spine x-rays were taken on 64% (N = 165). Not all participants in the study were able to acquire x-rays in time for the study. The cervical x-rays were evaluated to determine the state of the natural cervical curve and to look for signs of early degeneration (arthritis), another type of MSD associated with poor posture. Among that population, only 5% of the patients had what would be considered a "normal" anatomical curve and 95% had abnormal curves of varying degrees. A comparison was made using the LPS. The 5% of patients who presented with a normal cervical curve and MSD pain symptoms had an LPS of 10.5%, and the 95% of patients who presented with abnormal cervical curve, 11.6%, just over a 1% difference. Accordingly, their respective costs per case, per year were €1,443.10 and €1,597.10, an increased lost productivity cost of €154.00 for employees with an abnormal cervical curve.

7.3.2 Absenteeism; Statistical econometric outputs:

In following scientific protocol, statistical analysis of the absenteeism data was performed to determine if there were any significant findings and or differences among the related categories. Please note that one of the categories, *Onset to Treatment*, was not a measure of absenteeism but rather an independent finding included as one of the variables to look for statistical relevance. It is, in fact, the one category that nicely ties the WLQ and the Absenteeism studies together for the purposes of this research.

7.3.2a. Absenteeism Statistical Outputs

We began by making a linear regression as shown in *Table 18*. As mentioned above, the *Onset to Treatment* variable when comparing On-Site and Off-Site treatments did indeed prove to be a highly significant finding though not a measurement of absenteeism.

Table 17 Treatments & Consults; On-Site versus Off Site – linear regression

Independent Variables	Adjusted R2	B	Sig
Onset to Treatment	0.641	-83.971	0.00
Disability	0.270	-32.450	0.00
Treatments	0.298	-49.223	0.00
Medical Consults	0.270	-19.347	0.00
Diagnostics	0.215	-1.814	0.00
N = 273			

The statistical evaluation of this finding demonstrated high statistical significance. All very robust. Onset of symptom to treatment demonstrated the greatest variance between On-Site and Off-Site. Disability and Treatments are the primary causes of MSD related absenteeism. Consults and Diagnostics, though statistically significant, demonstrate a slightly lesser overall impact.

7.3.2b. Statistical Analysis of Absenteeism Data: Mean differences.

The mean differences between the On-Site (N= 163) and Off-Site (N= 111) demonstrated a very strong statistical significance, all categories with a 95% confidence level of the difference.

Table 19 below shows that the On-Site treatment compared to the Off-Site treatment among all four categories is statistically superior in avoiding absenteeism.

Table 18 Statistical Analysis of Absenteeism Data: Mean differences

Absenteeism Variables	Statistically significant mean differences	
Q2 Disability	(t(117.583)=8.477; p<.001)	
Q3 Treatments	(t(169.042)=13.567; p<.001)	
Q4 External Consults	(t(167.547)=9.270; p<.001)	
Q6 External Diagnostics	(t(183.525)=8.183; p<.001)	

7.4 Summary of Results

The following sections 7.4.1 and 7.4.2 are a brief summary of the results of the Productivity study and the Absenteeism study respectively.

7.4.1 Summary of MSD Impact on Productivity

We have satisfied Hypothesis 1; *MSDs Increase Productivity Losses*. This study using the WLQ to measure the impact of MSD on employee productivity, clearly demonstrated that MSD significantly and negatively impacted employee productivity among every category; Time Management, Physical Work Tasks, Mental-Interpersonal Tasks and Output Tasks. The RCT clearly and significantly demonstrated that an On-Site clinical approach to treating MSD in the workplace, dramatically improved employee performance measures across all the categories with only an average of eight treatments, whereas the control group whom did not receive treatment became worse across nearly all categories thus increasing the negative impact of MSD on productivity. The study also revealed a direct correlation between increased age and increased MSD related productivity losses as well as a wide range of clinical symptoms, thus exposing the value and importance of preventive measures to maintain a healthy and productive workforce as they age.

We have satisfied Hypotheses 2; *On-Site MSD intervention Reduces Productivity Losses*, having clearly established, through scientific method, that MSD had such a negative impact on employee performance (average 10.5%) at great economic, financial, competitive and productivity costs to the employer and that On-Site treatment decreased those productivity losses (to average 1.8%). It stands to reason that, treatment/intervention as well as preventive measures for such conditions within the workplace is a sensible business strategy that can be incorporated like any other business strategy designed to increase or retain corporate profits. Simply stated, the health of a company will determine the wealth of a company.

7.4.2 Summary of On-Site vs. Off-Site Impact on Absenteeism

We have demonstrated clearly that the On-Site treatment of MSDs among the employee populations has proven to avoid, therefor potentially reduce, MSD related absenteeism and associated costs among the three employee populations. By doing so, this research has satisfied hypotheses 3 which stated; *On-Site MSD clinics will decrease MSD related Absenteeism* and hypotheses 4; *On-Site MSD clinics will decrease MSD related Absenteeism Costs* through the use of empirical data and statistical analyses with a 95% confidence level of the difference between On-Site and Off-Site approaches of all four categories; disability days missed from work, treatments, consults and diagnostic consults.

8.0 DISCUSSION

8.1 WLQ Results

Firstly, we were not expecting MSDs to cause such a dramatic reduction in employee productivity. Intuitively, based on clinical experience, it was assumed that there would be some degree of productivity loss, but not as high as the 10.5% demonstrated in this study. Secondly and equally surprising, we were not expecting that the On-Site treatment would have such a high impact in reducing the average productivity loss to only 1.8% primarily because the treatment subjects only received an average of 8 treatments over the 16-18-week period. It was also surprising that the lost productivity score of the control group increased during that same period. This demonstrated that MSD conditions, if left untreated, do indeed reduce the quality of productivity of employees which lead to greater losses over time. Likewise, the highly positive results of this study far exceeded expectations relative to other studies as well as demonstrating a much higher productivity impact than other studies. The work that inspired this study was done in Madrid by Abásolo and a large research team in 2005 where they created MSD specific clinics in the community health system to reduce work disability related to MSDs. By streamlining the diagnostic and treatment processes, they managed to save the health system millions of Euros in unnecessary consults and return people to work in less time, often days or weeks, thus, reducing disability and likewise reducing millions of hours of lost productivity. With proper funding and the help of research teams in Europe, they managed to duplicate their process with successful results. The On-Site MSD intervention takes the work of Abásolo and team to a much higher level by avoiding much of the disability from the start and reducing costs to the health system by reducing diagnostics, consults and surgeries.

The WLQ questionnaire was not used to compare On-Site with Off-Site but rather to establish the productivity impact that MSDs have on a population suffering with MSDs at the workplace. The patients were employees actively seeking treatment for their MSD conditions exclusively at the On-Site MSD clinic in their respective organizations. We successfully demonstrated that the lost productivity associated with MSDs does in fact cost organizations real money. Arriving at exact costs was not possible without access to the actual salaries of each subject in the study, thus the average salary formula was applied. These numbers are not fully accurate but they do satisfy the

hypotheses that there is a cost to lost productivity and a substantial decrease in costs when an On-Site MSD clinic is used by employees of the organizations.

Though this is primarily a cost study for the sake of answering the question of how much MSDs are impacting productivity and therefor the bottom line of organizations, clinical data was also extracted to uncover any clinical correlations as to the possible causes of the most common MSDs in the work place such as low back pain and neck pain. The extraction of clinical data and measuring the impact on productivity is another original aspect of this study that revealed several correlations that were once intuitive and have now been measured and tested statistically.

8.2 Absenteeism Results.

We believe that this study has shed light on factors which contribute to absenteeism that previous studies and organizations have failed to consider or measure, those factors being, treatments and consults that took employees away from their work. This, in the opinion of the author, is a very narrow perspective, by previous researchers, that neglects to consider the lost productivity associated with treatments and consults and therefor, a missed opportunity to reduce these losses for private and public organizations alike.

We were uncertain as to what the outcomes would be but were pleasantly surprised at how successfully the On-Site model exceeded expectations and reduced absenteeism for treatments but to a greater degree, disability days missed. The study results clearly demonstrated that, employees with quick and easy access to the MSD specialists On-Site, miss fewer days work. Rather than miss hours or days of work due to their MSD condition, this study demonstrated that employees with access to the On-Site clinic came to work to be treated in most cases.

We were expecting that external consults and diagnostics would have caused more absenteeism than the study demonstrated. Though the empirical data and statistical analysis validated the hypothesis, the greatest impact came primarily from disability days avoided and time required for treatments. The work missed for external consults and diagnostics was very small in comparison to external treatments. We thought it would be higher. We fully expected that treatment times would be greatly reduced based on the past 12 years of practical clinical evidence that an employee with easy access to treatment only leaves their desk for half an hour or less compared to an average

of two hours for external treatments. It was highly rewarding to have demonstrated this hypothesis through the scientific method, thus supporting the business case for the On-Site approach.

8.3 Contribution to Academic Business Knowledge.

The unique approach of this study compared to any other study found in the literature, the On-Site intervention for MSDs, is a more effective business strategy than sending employees Off-Site for the same or similar intervention. We also improved upon previous, European wide MSD early intervention productivity impact studies that only considered short- and long-term disability as the only measures of productivity losses but did not include an On-Site approach, nor did they measure presenteeism or medical consults as sources of lost productivity (Abàsolo, et al., 2005; Fit for Work Europe, 2013). Thus, we added to the greater body of academic knowledge concerning MSDs impact on society, more specifically, within organizations. In addition and more specifically, the study, with high statistical significance, clearly demonstrated the financial impact that MSDs have on productivity losses caused by presenteeism and absenteeism, in addition, that such costs can be reduced by implementing an On-Site intervention clinic within organizations that would yield greater economic returns than previous models. In the context of management science, such studies can be used as valuable business cases for MBA students and existing managers looking for solutions to the costs and challenges associated with employee productivity losses and absenteeism. In the context of medical economics science, such studies can be used for the investigation of cost/benefit analyses projects and the development of potential government strategies and or policies surrounding workplace MSD management and or employee health management strategies.

8.4 Practical Implications of the Research

If such measurements were applied to the U.S., where the employer pays the full cost of consults, treatments and diagnostics, this would translate into staggering direct health care cost savings per case and per year. As Known Study number 14; "*A benefit-cost analysis of a worksite nurse practitioner program: first impressions"* (Chenoweth et. al., 2005), demonstrated, employees with a history of MSD issues are more frequent users of MSD intervention services in the future (post-incident), thus an On-Site approach could potentially result in substantial future cost avoidance for the organization due to easy, quick and efficient access to treatment.

The results of this study can be used to develop a useful tool for business decision makers and their HR directors, to determine the potential costs of not treating an employee population suffering with MSDs. Ultimately, evaluations via questionnaire and or physical exams should be part of an organizations HRA (Health Risk Assessment) process. This way, the formula can be applied to any size employee population to arrive at an estimated cost of lost productivity associated with MSD sufferers. Armed with the knowledge that MSDs, such as active neck and low back pain, have been shown to cause substantial absenteeism and productivity losses, thus substantial financial losses for the organization, an HR(Human Resource) director can justify to their superiors, investing in an On-Site MSD clinic for the sake of early intervention/treatment, as well as perform screenings for prevention of future losses. The HR director, or whomever is tasked with evaluating the benefits of installing and integrating an MSD clinic into their organization, would need to do their own cost-benefit analysis to determine, based on the cost of installation and on-going services, if the On-Site clinic would save their organization money in the long run based on the lost productivity score (LPS) of their population. The WLQ comes in a short form of only 15 questions and could easily be implemented into an employee health screening process.

The randomized, control, trial (RCT) portion of this study revealed that the lost productivity score (LPS), and consequently, associated total costs of MSD, increased with age, as do MSD symptoms, shedding light on the need for early intervention and prevention strategies to maintain a healthy and productive work-force as they age. The Study subjects (treatment group) revealed a significant drop in the WLQ score by a factor of 5.7, compared to the Control group, which increased by 1% over the 16-18-week period.

The study also demonstrated that patients under care in the On-Site MSD clinics have absenteeism rates far lower than the Off-Site patients. There are several factors to be considered. Firstly, the On-Site group had been taking advantage of the services for the past year. Their conditions were no longer acute in most cases, and were being treated on a maintenance basis, once every four to eight weeks. Secondly, the On-Site group has easy access to treatment if they have an acute pain crisis, which they typically came to work to be treated rather than stay at home. Thirdly, the Off-Site group, when in crisis, typically didn't have any other option but to stay home rather than come to work in pain. They were also forced to miss more work for external consults and diagnostics.

Again, there is tremendous potential for substantial absenteeism cost savings for organizations that invest in the On-Site MSD clinic concept, if only to keep their employees at work to be treated, and away from Off-Site, external hospitals and clinics, which this study shows, leads to much higher rates of absenteeism and associated costs/losses to the company.

The clinical aspect of this study also revealed that poor posture, which most frequently is seen with FHP (Forward Head Posture), is directly associated with neck and low back pain as well as mid back pain and upper and lower extremity pain. Poor posture has reached epidemic proportions globally in the past ten years. A quick look around in any public place, in nearly any country world-wide, one will see many people of all ages and genders with rounded shoulders and FHP, often, looking down at a mobile device or working on a lap top computer. Posture analysis of employees could be, and frankly, should be part of an organization's employee health screening process. The literature review, combined with this study, clearly revealed that MSDs cost organizations more money than heart disease, diabetes and cancer combined in both direct and indirect costs, and the research showed that poor posture contributes to those same health risks.

In Portugal, as with all EU member states and the United States, every company is required by law, that their employees undergo health check-ups each year. The check-up typically consists of checking blood for diabetes and cholesterol risks, blood pressure for cardiovascular risks, and some-times, chest x-ray for pulmonary risks. None of those "risks" have an immediate and wide-spread impact on the general employee population to the degree that MSDs do. To my knowledge, posture evaluation is not part of the required typical check-up process in any company. Perhaps Cervical spine x-ray should become policy, considering that poor posture and abnormal cervical spine curvatures, according to this study, effected 95% of the population. Based on this research, an On-Site MSD clinic is a preventive approach to health, and proactive approach to productivity, which is a logical business strategy for any organization looking to earn and retain higher profits through a healthy work force.

It is worthy of noting, that each of the three companies evaluated, have invested heavily in ergonomic strategies to prevent MSD. Such strategies included, investing in expensive, ergonomically correct, chairs, and evaluation of computer workstations by professional ergonomists. Regardless of such investment, employees still suffer from neck and back pain and other MSD issues caused by sitting for several hours per day working on computers.

When the calculations are applied using U.S. wages, it becomes clear that productivity losses and absenteeism combined, costs much more for U.S. organizations than direct medical costs alone, especially for the white-collar workers, who earn substantially higher salaries than the average worker, by as much as a factor of 10 in some cases. When absenteeism figures are factored in for Off-Site consults, treatments and diagnostic imaging, the figures again are exponentially higher than their Portuguese counterparts.

Most organizations lack a critical piece of context about musculoskeletal health, and some organizations completely miss it. The bottom line is: managing musculoskeletal health efficiently and effectively is a massive opportunity that can impact entire organizations. Such management would impact safety and wellness, yes, but it would also dramatically impact other areas of the business such as; productivity, company culture, and brand equity. As the U.S. is scrambling to control health care spending within their organizations, perhaps it would be beneficial to begin looking at MSDs and On-Site interventions as an intelligent use of resources to develop an effective cost savings business strategy. Translating these results for the "self-insured" organizations in the U.S., this strategy equates to several million dollars of savings per year in direct health care spending.

As the EU member states are looking for methods to decrease health care spending and productivity losses, the On-Site MSD intervention clinic solution is worth investigating further and repeating the methods used for this study. The Portugal SNS would benefit from performing similar studies among a wide array of organizations. The cost of the On-Site MSD clinic would need to be calculated in a cost-benefit analysis and possible future policy making.

The research revealed that there are three major flaws in MSD management: 1. A reactive approach that perpetuates a downward spiral in direct and indirect costs, 2. Organizational silos which lower the effectiveness of solutions and 3. Lack of common goals, tools, and reliable information that hampers decision making related to MSD management. The reactive approach is an example of how organizations lack a true understanding of the seriousness of MSDs in the workplace. Traditionally, MSD management is done by addressing MSDs as they occur. This is a failing model, as studies demonstrate that MSD costs are on the rise Globally. This is because such reactive tactics are simply unsuccessful in the long term, because causative risk factors such as poor posture, poor ergonomic risks etc. go undetected. It is only a matter of time that these

undetected risk factors translate into musculoskeletal injuries, pain and associated direct and indirect costs. The qualitative research project that preceded this thesis revealed that the departments within organizations, such as, human recourses, occupational safety and health, medical providers and department managers, appear to operate in their own individual silos, with little communication among each other. Such uncoordinated and reactive responses to MSD health issues, renders management efforts ineffective. There is no synergy, and a coordinated solution to MSDs is missing because nobody in the organization has the proper tools and information to recognize it. Thirdly, there is the lack of common goals, tools and information. All the stakeholders and disciplines involved with MSD management, rely on their own, often competing, goals, tools and information. What is needed are, common goals, using the same tools and coordinating the information among; management, safety, engineering, HR, wellness, medical treatment, ergonomics and On-Site health care.

8.5 Research Limitations:

Some of the limitations relate to cost and time. In fact, this study was very expensive and time consuming to perform. The project was originally intended to use U.S. based, self-insured corporations for evaluation of direct medical costs, as well as presenteeism and absenteeism costs, for reasons stated earlier, that U.S. corporations are looking for health care cost savings strategies because they carry the burden of all healthcare costs. Attempting to establish On-Site clinics in the U.S. market proved to be very challenging and costly, requiring several flights to the U.S., dozens of meetings with different companies, hiring a consultant for two years as well as several months of opportunity costs incurred from not working in the private clinics in Lisbon. It was a three-year process, partially and conditionally subsidized by Portugal 20/20, that did not bear fruit as of the writing of this thesis. It also delayed the completion of the study by at least two full years.

The decision was made in September 2017 to use the three companies in Portugal for this study because it became an unachievable objective to obtain a U.S. client for the study in time to complete the PhD by December 2018. Fortunately, a third company became a client of the Lisbon based, On-Site MSD company in March 2017, thus allowing for a larger sample size and added a third business sector. Using the three On-Site clinics in Portugal for the study did not allow for

the evaluation of direct medical costs associated with MSDs but did provide a very rich clinical sample for obtaining productivity and absenteeism metrics.

Getting authorization for using the validated instrument, WLQ, proved to be quite challenging. Due to some internal lack of e-mail communication within the university, the author's request went unanswered for over five months. Fortunately, the initial potential sample for the WLQ was being sourced starting in November 2017. At that time, the On-Site MSD intervention company was permitted to send emails to the employee populations looking for volunteers. Starting dates were set in January, then again and February, but due to no response from the university, the study could not start. Dates were reset each month until finally in June, the documents were signed by the university lawyer and the WLQ was released for use in the study. Unfortunately, due to changes in EU data protection regulations that were implemented on May 25th, 2018, re-contacting the initial participants became even more challenging and time consuming and required the help of the HR departments who already had hectic schedules and many responsibilities. Starting the process in late June, and during the months of July and August, also proved to be challenging, as those months were when most employees took their annual vacation time, thus reducing the sample size that was originally scheduled.

The logistical aspect of the study was quite complex for final execution and required many man hours to complete. Too large for only one person or average PhD student to complete in a few weeks. Fortunately, each of the On-Site clinics had a staff of three people who could assist in collecting data, but more importantly and time consuming, perform the physical exams required to establish the specific MSDs of each person and to later initiate the questionnaires with patients. The study was also limited to the days on which the On-Site clinics were open for operations. Also, being physically present during every stage of the study to supervise, required missed work in the author's medical practice.

Cost Calculations for the study:

We used average salaries for Portugal and the U.S. to determine the cost of lost productivity and absenteeism to the companies studied. Access to the actual salaries of the study subjects was unavailable. The subjects ranged from high level executives to entry level employees in all three organizations. Taking an average, at least provided us with a cost figure for the study. If actual salaries were available for each subject, the total cost impact would most likely be much higher.

Some other limitations relate to sample acquisition and man hour requirements:

The study could have been done over a longer period, and data collected on more subjects. The WLQ itself was very limiting, in that, the time frame of every question was; "In the past two weeks…". This posed a great logistical challenge for the way the study needed to be organized. Originally, subjects were selected through the currently active patient data base, and randomly selected 100 patients from each clinic who had been under care in the On-Site clinics. It would have been a much simpler process to use this sample, since all the physical exams had already been completed as part of the typical clinical procedures for each patient. After discussions by phone and several emails with the developer of the WLQ, Dr. Debra Lerner, from Tufts Medical Center in Boston, it was decided that a new sample be created as not to interfere with the accuracy and validity of the psychometric components of the WLQ. Again, this put a tremendous pressure on clinic staff and the HR departments to promote and acquire an entirely new cohort of patients for the studies. The process required many additional man hours from clinic staff and the cooperation of the volunteer employees to be present in the clinics on different occasions; 1) examinations, 2) WLQ Phase 1 and Phase 2 and, 3) absenteeism questionnaire. The additional subjects became new patients in the clinics, thus straining the capacity efficiencies in each clinic for the purposes of this study over an 18-week period. It was the only way to remain true to the "…past two weeks" design of the WLQ and add rigor to the study.

Execution of the absenteeism questionnaire for the Off-Site group was a major challenge and required a coordinated group effort between the clinic staff, HR departments, and department managers, to allow staff to participate during work hours. The process was disruptive to the daily operations of the organizations studied, if only for a few minutes per person. Ironically, the study itself caused some degree of absenteeism and lost productivity. The author did not measure the absenteeism caused by the studies.

In the context of the study sample population, the study represented employees in primarily computer-based jobs and thus cannot be used as a true representative sample of the greater Portuguese population. This does provide an opportunity to do further research in this area among a wider range of industries and employee populations within Portugal and beyond. It stands to reason that MSDs would have the same or similar impact among a wide range of industries. It would be interesting to discover outliers.

Emotional State and Memory of the Subjects:

As a physician and clinician with over 30 years of experience, the author has observed that the patients' level of pain and or degree to which their pain impacts their performance is highly influenced by their emotional states at the time of questioning. Though the WLQ attempts to measure emotional components and claims to do so with a high degree of statistical certainty, it has been the authors professional experience that the patients recall over the past two weeks, could possibly be different depending on their emotional state the day, and perhaps even the time of day, the questions are being asked. Perceptions and recall of pain can be different from one day to the next. The WLQ was chosen as the most accurate and statistically reliable tool among several different options evaluated. No other tools demonstrated such a high level of reliability. Patients in each group also expressed that their physical symptoms increased as the day went on, and they reported feeling less productive in the afternoon than in the morning. The WLQ frames some of the questions as to the persons perceived physical and organizational abilities in the early hours of the workday. Perhaps there is room for improvement by weaving in a time of day factor into the instrument.

9.0 CONCLUSIONS:

9.1 MSD Theoretical Foundation:

Musculoskeletal Disorders (MSDs), primarily neck and back pain, have been shown to be a tremendous Global burden on society, costing billions of dollars each year to treat as well as billions of dollars in lost productivity, disability and absenteeism. Furthermore, MSDs negatively impact the health of more people globally than nearly any other disease known to man including heart disease, diabetes, HIV-AIDS, lung disorders etc., just to name a few. For the employers in developed countries around the world, MSDs, primarily back pain, have been shown to be the single greatest cause of long, short and permanent work disability as well as the primary driver of direct and indirect costs and the most common reason employees seek medical advice. Unfortunately, until now, there are very few studies that demonstrate the impact MSDs have on the work performance of employees. Most studies only measured the impact of MSD after an employee has sought medical attention, a purely reactive methodology. Productivity losses caused by MSD have only been measured by looking at the days an employee has been absent from work. European and U.S. studies only measured productivity losses associated with disability, a very narrow perspective that is after the fact. An employee can be suffering from MSD related pain for weeks or even months prior to seeking treatment. Employers currently only look at the days missed from work and the direct costs associated with MSD but do not focus on how MSD directly impacts the productivity of working employees every day. Very few organizations offer any kind of MSD treatment on-site for employees, thus, employees must seek medical advice and treatment externally which increases productivity losses and absenteeism rates. Current "best practices" for MSD sufferers are purely reactive at best, and merely reduce disability time frames. MSDs are not addressed by WPWPs, nor by most current On-Site clinics regardless of the profound research and economic evidence. Organizations spend great sums of money on ergonomic approaches to prevention, yet research has yet to demonstrate a significant reduction in MSD incidents and

associated costs among white collar populations, only among manual labour, industrial and manufacturing sectors.

Presenteeism, the phenomenon when an employee is at work but not working productively to their full capacity, has become a trendy topic among most organizations, yet few managers have any understanding as to what it truly means or what, if anything, they can even do about it. Presenteeism has been shown to cost organization more in financial losses than absenteeism or direct medical costs. Current and past research has yet to measure and therefore demonstrate, to what extent, neck pain and back pain influence presenteeism, until now with the results of this study.

This study has successfully demonstrated a correlation between MSDs, presenteeism and absenteeism, by measuring the productivity losses and absenteeism rates of employees suffering daily with MSDs.

9.2 Productivity Losses and Associated Costs: Hypotheses 1 & 2.

In the first instance, both the Phase 1 and Phase 2 studies demonstrated that MSDs do indeed result in a loss of employee productivity which results in associated costs to the organizations studied. In the second instance, the On-Site MSD intervention clinic reduces productivity losses and associated costs by a factor of nearly 6 times across the three companies and by a factor of 11.5 times for the older population group. As a matter of interest as to which categories had the greatest impact on productivity, it is noted that time management tasks; physical tasks; mental-interpersonal tasks and output tasks were measured. The most significant improvements were within the physical tasks, and output tasks, indicating that they were more productive performing the required physical tasks of their jobs such as walking, bending, lifting, sitting, and more capable at completing their job tasks and workload on time, respectively.

This study has revealed several conclusions beyond the initial hypothesis, which are highly significant to business management research, more specifically, a real-world evidence (RWE) (Sun et al., 2018; FDA Science & Research, 2019) study and application of a business strategy that considers the health of employees as significant to employee performance management. Satisfying hypotheses 1 and 2, we have clearly analyzed, measured and statistically verified that MSDs do

indeed cause lost productivity among employee populations on average by 10.5%, and that an On-Site MSD treatment clinic was shown to dramatically decrease productivity losses (10.5% to 1.86%) and associated costs (€1,197.71 to €118.13) respectively, per person per year with an average of only 7-8 treatments over a 16-18-week period.

In addition to positively confirming the hypotheses, the study shed light on several other factors that proved to be significant to overall employee productivity. For instance, there was a difference in productivity losses among the three organizations studied, which appeared to be directly correlated to the average age of the employee population and was later statistically confirmed with a 95% confidence level in the statistical data analysis. As such, it was revealed that the younger population had the lowest productivity loss percentage, and the older population, the highest. We can confidently conclude that the older the population is, the more MSDs negatively impacted their productivity thus increasing their cost to the employer by over €560.00 or nearly 70% per case per year compared to younger employees (in Portuguese Euros). When the calculations are done from the youngest employee, age 24 to the oldest employee, age 63, the cost difference is over 80% higher for the older employee.

The study also demonstrated that female employees have a higher productivity loss score than men by one percentage point thus, female employees cost the organization more than male employees per case per year for the same or similar MSDs by nearly €125.00 or over 9% more costly on average, though statistically, gender was not found to be significant.

The study also arrived at some clinical conclusions in relation to productivity losses. Several statistically significant ($p < .001$) correlations between clinical symptoms and productivity losses were revealed using linear regressions and 2-tailed Pearson correlation evaluation, including; forward head posture (FHP), neck pain, mid and low back pain and upper and lower extremity pain. As stated previously, the MSD symptoms mentioned above were found to result in an average productivity loss of 10.5%, but some conditions individually and in combinations were responsible for higher than average losses by as much as 6%. The incidence and impact of neck pain and low back pain on productivity were nearly identical in this sample, 11.49% and 11.47% respectively. Upper extremity pain was the single symptom with the highest lost productivity score of 11.62% and forward head posture (FHP), the lowest single symptom but still significant, with a score of nearly 11%. Of all the combinations of symptoms evaluated, there was less than a

1% difference in productivity losses. It is interesting to note that low back pain, frequently cited as the primary cause of disability and missed-days' work (Hoy, 2014), demonstrated a lower productivity loss when combined with leg pain than with mid back pain with 11.91% and 12.96% respectively. In evaluating the questions to understand why this was, it was noted that the combination of mid back pain and low back pain resulted in more frequent work brakes or need to rest during the day. Digging deep into each of the WLQs' 25 questions has revealed valuable clinical and psychosocial data that is beyond the scope of this productivity study. The study clearly demonstrated that MSDs have a negative impact on an employee's ability to manage time, perform physical tasks, engage with co-workers and complete their workload effectively and on time. The study also demonstrated how an On-Site MSD clinical treatment can positively impact employee productivity on all metrics.

In relation to lost productivity costs and clinical findings, employees with a "normal" cervical curve cost less than employees with "abnormal curves". It should be noted that less than 5% of the entire study population who provided X rays demonstrated a "normal curve", thus 95% of the population demonstrated an abnormal curve which likewise cost the employer more in lost productivity by nearly 10% per person per year. These X-ray findings of abnormal cervical spine curves were strongly correlated with a higher WLP lost productivity score. We used the Pearson Chi-Square Tests or "goodness of fit" statistical evaluation (($X^2(12) = 93{,}267$; $p < .001$), demonstrating that a loss of cervical curve is associated with a loss of productivity in the workplace with a high (95%) confidence level.

Anecdotally, during the Phase 2 WLQ process, over 90% of the test subjects/ patients reported that they had more energy and elevated moods during the treatment period. The level of energy or mood was not measured but could be an interesting future research project on employee cognitive function.

9.3 Absenteeism Losses and Associated Costs: Hypotheses 3 & 4.

The following conclusions are associated with the absenteeism comparison between On-Site and Off-Site interventions for MSDs. As was stated earlier, the calculations were done in days, hours and converted to Euros based on average national salaries in Portugal.

The study clearly demonstrated a significantly lower percentage of absenteeism by all measures, including; disability days of missed work, total hours missed for treatments, total hours missed for medical consults and total hours missed for diagnostic imaging. Therefor, this research has satisfied hypotheses 3 which stated; *On-Site MSD clinics will decrease MSD related Absenteeism.* The study clearly demonstrates that, employees with quick and easy access to the MSD specialists On-Site, miss fewer days work, require fewer treatments per case, have fewer medical consults per case and are sent for fewer diagnostic imagery consults such as X Ray, MRI, CT scans or EMG per case. All of this equates to a substantially lower total rate of absenteeism and associated costs for the On-Site treatment population by a factor of 4. Therefor, hypotheses 4; *On-Site MSD clinics will decrease MSD related Absenteeism Costs* has been shown using empirical data and statistical analyses with a 95% confidence level that the On-Site approach decrease and prevents absenteeism costs for organizations.

Comparing the On-Site and the Off-Site models, the most significant findings as to the causes of absenteeism related to MSDs were average total disability hours per year (4.88 hrs vs 37.33 hrs) and hours for treatments (10.02 hrs vs. 24.35 hrs) respectively. Total average absenteeism in working hours per-person, per-year, On-Site vs. Off-Site were, 16.62 hours and 68.38 hours respectively, which translated into €108.07 and €444.72 respectively. The Absenteeism study revealed Statistically significant mean differences between the On-Site and Off-Site groups. The categories measured included; 1.Disability; ($t(117.583)=8.477$; $p<.001$), 2. Treatments; ($t(169.042)=13.567$; $p<.001$), 3. External Consults; ($t(167.547)=9.270$; $p<.001$), and 4. External Diagnostics; ($t(183.525)=8.183$; $p<.001$). There was a very strong and statistically significant correlation between total absenteeism, On-Site vs. Off-Site, with statistically significant mean differences ($t(273)=-20.022$; $p<.001$). It was also revealed that the average time an employee needed to wait, from the time of onset of symptom, to the time of first treatment, was 3.6 days (28.8 working hours) for On-Site and 14.09 days (119.2 working hours) for Off-Site respectively.

Total days of work missed from ***disability*** caused by the employees MSDs category, demonstrated the greatest difference in absenteeism between the On-Site and Off-Site options. The average number of hours missed per year by the On-Site group was 5 hours (4.88) compared to the Off-Site group with 37 hours (37.33). Put another way, when calculating the total number of missed hours during the year, the On-Site subjects missed less than one full working day during the year

due to their MSDs and the Off-Site subjects missed more than four full working days on average per year due to disability, treatments and consults. This finding represents a seven times greater rate of short-term disability among the Off-Site group for that single category, disability, compared to the On-Site group.

The total absenteeism hours per year per person by category, *excluding disability* (missed days-work): On-Site: 11.73 hrs. vs. Off-Site 31.05 hrs., or 1.5 working days and 4 working days respectively. Average absence for all external consults: On-Site: 0.82 hrs. vs. Off-Site 4.0 hrs.; external diagnostics: On-Site: 0.89 hrs. vs. Off-Site: 2.70 hrs.

The total average absenteeism cost of lost wages per person per year for *all categories* (disability, treatment, consults, diagnostics) combined was; On-Site: €108.07 vs. Off-Site: €444.72 and for the categories of treatment, consults and diagnostics combined was; On-Site: €76.25 vs. Off-Site: €201.92. Simply put, the companies who use an On-Site MSD intervention clinic for their employees, appreciate on average, greater than *four times less absenteeism* rates and related costs than companies who do not use an On-Site intervention clinic.

The study clearly demonstrated that an On-Site MSD intervention clinic model is a logical, practical and intelligent business practice for enlightened business leaders looking to reduce productivity losses, absenteeism and associated costs.

Finally, in reference to the title of this research, "On-Site vs. Off-Site practices of MSD intervention and its impact on Organizational Productivity, Absenteeism and Costs. Theoretical analysis with application", On-Site MSD interventions have been shown to exponentially reduce MSD related productivity losses, absenteeism and associated costs of both phenomenon to a high and statistically significant margin compared to Off-Site or no intervention practices with a 95% confidence level for nearly every category evaluated.

9.4 Business Applications of the Study:

The primary purpose of writing this paper and performing this study is to obtain a PhD in Business Management. I will discuss the relevance of this study, why proving the hypotheses was a necessary step toward building a business case to support the application of this research in the field of business. The results of this research will potentially impact academia by bringing together

the disciplines of business management theories, health care research, human performance studies and socioeconomic studies for policy decision making. Fundamentally, the outcomes of the study are primarily business in nature, regardless of the clinical and medical context (MSDs) of the phenomenon studied as the primary causes of employee productivity losses and absenteeism. The bottom line is, this research has clearly demonstrated that employee health has a direct impact on organizational performance, thus, managers must be made aware of successful strategies and proven methodologies in order to strategically manage the potentially negative financial and social impact of health issues on organizational performance. The literature review revealed that MSDs have a substantial negative impact on society as a whole, and were found globally to be the primary causes of lost productivity and work absence among employee populations (Shariat, Cardoso, Cleland & Danaee, 2018) yet, there is a lack of scientific representation in academia (Perruccio,Yit, Power & Canizares, 2018). It seemed logical to measure to what extent MSDs impacted these phenomenon as well as to measure using scientific method and real world evidence (RWE) based research applications (Sun et al., 2018; FDA Science & Research, 2019), the effectiveness and to what extent, a real world solution could impact said phenomenon. The health care community and policy makers use RWE data, such as the primary data from patient electronic health records used for this study, to support treatment coverage decisions and to develop guidelines and decision support tools for use in clinical practice (FDA Science & Research, 2019). Having over thirty years' experience in treating MSDs and being the CEO and Clinical Director of a Corporate On-Site MSD Clinic company, such research was a natural progression of the author to build a scientifically based business case for the validation and eventual expansion of the On-Site MSD Clinic business model as a logical business strategy for corporate clients looking for a higher ROI for their employee health investments and health care professionals specializing in the treatment of MSDs. The primary tool used to determine the productivity losses (WLQ), can be used by managers responsible for WPWPs or On-Site clinic implementation as well as employee performance metrics and outcomes, to accurately determine and quantify the cost of neck and back pain or other MSD issues on their employee populations, valuable information that managers typically are unaware of, thus, missing an opportunity to positively impact organizational human and fiscal performance.

From the business perspective, this scientifically based, RWE (FDA Science & Research, 2019) employee performance impact research has revealed an excellent business opportunity for

corporations to save money on health care expenditures and for health care professionals specializing in MSD treatment to join or create a low cost, high ROI, On-Site clinic model. We shall look at the two business market targets for this project; 1. corporations looking to save money and increase employee productivity and 2. MSD specialist health care practitioners and providers, looking for new business opportunities. The business model can be applied in any corporate situation, regardless of the payment schemes used, such as private insurance, fixed fees for services or NHS reimbursements. The following sections, 9.4.1 and 9.4.2 are an example of the business applications supported by this research study and what makes the On-Site approach a more cost effective and clinically effective business model from a medical economics perspective than traditional WPWPs and primary care On-Site clinics alone.

9.4.1 Corporate Target Market.

The On-Site MSD clinic provider currently has corporate clients with similar working conditions but different average age groups. Previous research, in an 18-month research study with 400 employees (Hatch, 2012) revealed that the younger patient population, average 27 years old, suffered more neuro-musculoskeletal complaints than the older population, average 52 years old at the time of the study. This pointed to a potential future of increased medical costs, decreased productivity and lower corporate profits as a direct result of poor posture. The most recent study, which is this PhD thesis, revealed that the older population suffering with MSD, cost more to the corporation in lost productivity than the younger population but had fewer complaint combinations. If untreated, the younger populations, with more clinical complaints, will eventually become an even more costly burden as they get older. Part of the On-Site MSD clinic providers business offering is data collection, patient surveys and ongoing clinical research, to determine the causes of neuro-musculoskeletal conditions in the workplace. This thesis is a natural progression and extension of previous research done within the organizations by the author. This study revealed to what extent neck and low back pain are causes of lost productivity, medical expenses and absenteeism in the workplace. The On-Site MSD Clinic model deals directly with this resource draining epidemic. As covered in the literature review, traditional corporate wellness programs performed services such as cholesterol, diabetes and blood pressure screenings, diet coaching, exercise advice and work-life balance counseling (Anderson, et al., 2009). They charge high prices and provide very little ongoing, hands on care. These services are usually provided

only a few days per year. The On-Site MSD Clinic model provides all those services but performs treatments, exercise and therapy with each visit, with the emphasis on postural correction as an MSD prevention strategy, within permanent On-Site facilities, all year round. Such a business approach to MSDs allows for high performance, high volume of patients per hour per doctor, with outstanding, reproducible clinical results, patient satisfaction and high utilization. This research project now demonstrates with high statistical significance and confidence, that, the On-Site approach dramatically reduces productivity losses and absenteeism thus providing a substantial ROI for the organizations who implement such an approach.

Below is an ERRC Grid (Eliminate, Reduce, Raise, Create). This is a business tool developed by researchers Kim and Mauborgne in the area of Blue Ocean Strategy (BOS) (Kim & Mauborgne, 2004, 2017; INSEAD, 2019). The tool is designed to help companies focus on new opportunities (Blue Oceans) within existing industries (Red Oceans), (MSD off-site treatments & health care in this case) by getting them to simultaneously eliminate and reduce some aspects of the industry while raising and creating other aspects. For the purposes of this paper, the focus is on how the On-Site Corporate Clinic model is a BOS for MSD treatment vs. Off-Site treatment. First, we look at the Corporate Target in *Table 20* below:

Table 19 ERRC Grid for On-Site MSD Clinic model: Corporate Business Target.

ELIMINATE • External office visits for musculoskeletal conditions (the primary cause for medical visits, productivity losses and absenteeism)	RAISE • Productivity • Corporate profits • Employee compliance • Employee job satisfaction • Efficiency of care • Awareness of the link between posture, health and performance • Awareness about the financial benefits of preventive care • Benefit to cost ratios
REDUCE MSD Related Costs • Lost productivity (10.5% to 1.8%) • Absenteeism • Presenteeism • General Medical costs • Treatment cost per employee • Surgical interventions • Lost work time	CREATE • Health Care solutions • Healthy Corporate culture • Health specific analytics software to track patient progress and connect the dots between posture, health, performance and profits • Demonstrate ROI in real time

• Insurance Premiums • Employee turnover	• In-House full-service clinics • 24/7 Back office support, scheduling, electronic medical records • No extra costs or resources required other than space

We will now look at a Strategy Canvas (*Figure 19* below), another tool used to provide a visual presentation to compare a BOS (Blue Ocean Strategy) (Kim & Mauborgne, 2004, 2017) with existing strategies. In this case, we will compare the On-Site MSD Clinic (GWC) model with existing Corporate Wellness Provider (CWP) models as a business strategy.

GWC is the name of the On-Site MSD Clinic provider in Portugal, thus the name appears in the graph below. CWP stands for Corporate Wellness Provider, companies that provide typical corporate wellness services and primary care only, as explained previously.

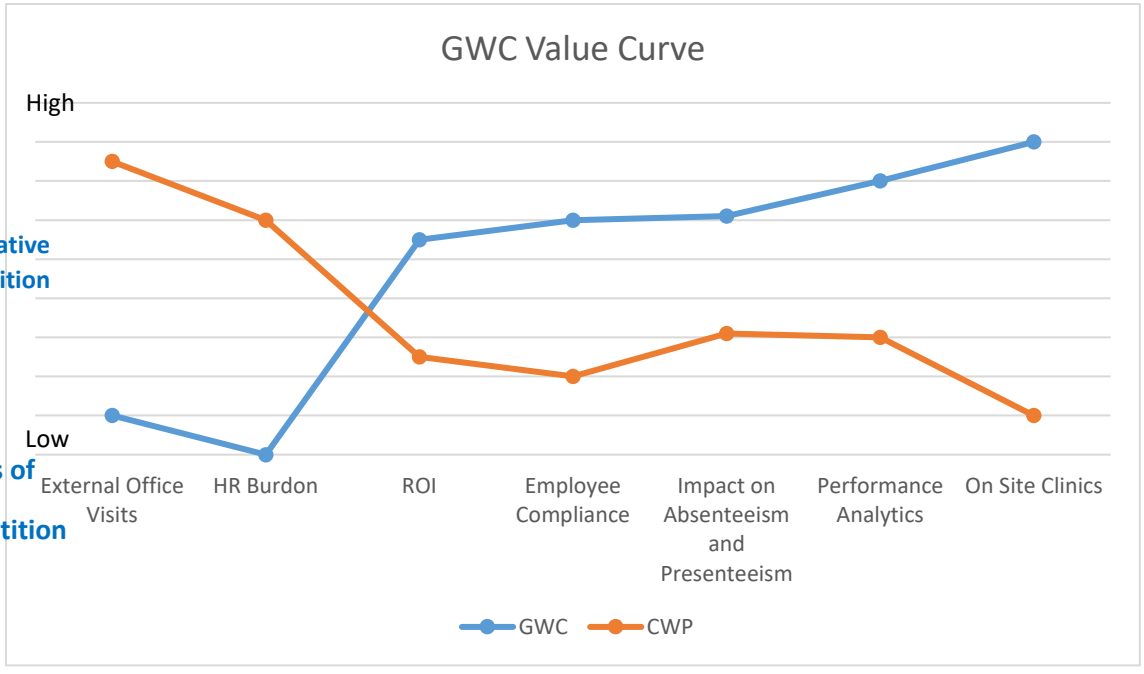


Figure 19 Strategy Canvas for On-Site MSD Clinic model: Corporate Business Target

9.4.2 MSD Specialist Practitioner Business Target

The average Doctor of Chiropractic, Doctor of Osteopathy, Physiotherapist or Manual Medicine doctor graduates from their program of study with around $130,000- $200,000 in financial aid debts in the United States (AAMC, 2019). Though this amount is substantially lower in European countries with subsidized educational systems, there are still very important considerations upon graduation. Some considerations are; how long will it take to pay off financial aid debts, how much will it cost to open a private practice, will the graduate qualify for a bank loan with such large university debts? The On-Site MSD Clinic model addresses these business and financial challenges for the healthcare practitioner. Another consideration is to target well established health care professionals and existing clinics looking to expand their practice using a low-cost satellite clinic with guaranteed monthly income that uses less expensive recent graduates looking for employment. Below in *Table 21*, is another ERRC grid which shows the benefits of the On-Site model for the MSD health care provider.

Table 20 ERRC Grid: On-Site MSD Clinic for MSD Practitioner Business Target.

ELIMINATE	RAISE
• Cost of building a new clinic • Rents • Utility bills • Need for marketing and advertising	• Doctors skill sets • Efficiency • Income potential • Professional Image and prestige • Opportunity for growth • Doctor satisfaction due to consistent, reproducible clinical results • Public awareness about the benefits of preventive care

REDUCE	CREATE
• Stress • Overheads • Startup costs • Number of staff • Liabilities • Insurance costs • Time required to pay back student loans	• Unexploited global market for Chiropractic physicians, Manual Medicine, Osteopathic Physicians, Physical Therapist • A new industry to serve the global health care crises • Proprietary clinical techniques, therapies and protocols • Jobs for recent graduates • Demand for new jobs in the corporate healthcare arena

The business opportunity for MSD specialists provides financial and professional benefits of private practice at a fraction of the cost. *Figure 20* below demonstrates a comparison between two options available to health care practitioners; 1, opening a private practice and 2, working in an On-Site clinic established by an experienced service provider. The categories are; 1. Startup costs, 2. Overheads, 3. Marketing Costs, 4. Work Stress, 5. Startup time (build out, planning, obtaining permits etc.), 6. Net income, 7. Job Satisfaction, 8. Clinical Experience and 9. Patient compliance. One can see that all costs are lower for the On-Site verses the private clinic option, income is similar as is job satisfaction and clinical experience. Patient compliance is typically better in the On-Site setting due to ease of access to care and the fact that there is no cost to the employee in most cases.

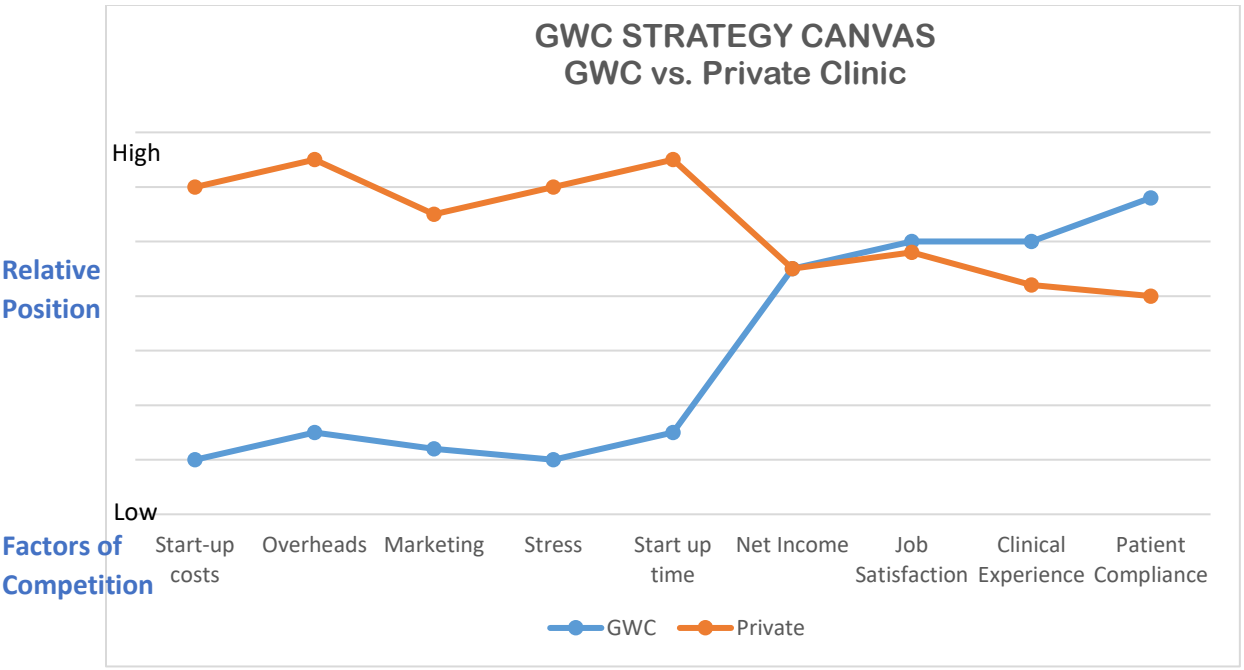


Figure 20 Strategy Canvas for Targeting Health Care Professionals

The On-Site MSD Clinic business model is currently being used in Portugal with great success and looking forward to global expansion. Current managers and business students need to be made aware of the financial and performance impact that MSD has on employee populations. This project can serve as a business case study for MBA students and MBA programs looking for innovative employee management and organizational cost control strategies.

9.5 Further Research

A substantial amount of additional data can be pulled out of these two data sets to search for further correlations between clinical findings and productivity losses. Such data could be used for epidemiological studies of employee populations, to determine primary MSD risk factors. Such data could possibly be used by policy makers in the future, looking to have a broader economic impact. Understanding that for each unit of lost productivity, for any of the clinical findings, including; neck pain, mid back pain, low back pain, upper and lower extremity pain, results in a *productivity loss of up to 3% for the organization*, is a valuable metric for policy makers looking to reduce the cost of lost productivity.

The author was fortunate to share the stage at IOSH (International Occupational Safety and Health) and BOSH (British Occupational Safety and Health) conferences in the U.K. on several occasions with Steven Baven, the director of Fit for Work Europe at the time he was fulfilling the obligation to speak in scientific conferences. Mr. Baven shared some enlightening thoughts concerning the need for future research on MSDs in the workplace, which were outlined during his lecture. His thoughts shed light on possible research opportunities: What will be the consequences of failing to improve our understanding, diagnosis, treatment and management of MSDs… for; individual workers, employers, the government and wider economy. What three things could a government do to minimize the economic and social consequences of these conditions? Which interventions would have the most impact for the least cost? What are the main barriers to the adoption of more enlightened and sustainable management of these conditions in employment settings? How could these barriers be overcome?

More cost studies need to be performed on MSDs to calculate the full cost to society. MSDs have a direct impact on a person's ability to work and may lead to short-term, long-term or permanent work disability. This could and does translate into significant associated costs to individuals, families, communities, employers and the broader economy. It is not a straight-forward task to calculate exact costs as several factors need to be considered, making accurate, reliable and consistent calculations a serious challenge. As an example, short term disability payments or welfare payments are treated as "transfer payments" in Europe or "cost shifting" in the States (Hatch, 2014; Murphy & McCague, 2003). They move financial resources across the economy, but do not technically consume those resources. Such expenses, or the cost of MSD treatments need to be treated separately to obtain accurate cost figures. The costs associated with MSD vary greatly depending on the type of condition, the severity of the symptoms and if the condition leads to short or long-term disability/missed work. Actual costs also vary substantially depending on the methods used to calculate them. However, existing figures on the economic impact of MSDs, typically based on conservative estimations, clearly demonstrate that MSDs are a significant economic burden to the economies of most countries globally.

The following factors must be considered for the calculation of MSDs (or any illness). Direct costs: Including but not limited to medical expenditures, i.e..; prevention costs, detection, treatment, long-term care and ongoing medical and private costs. Indirect costs: *presenteeism, absenteeism,*

productivity losses, *lost earnings*, as this study measured, as well as opportunity losses for care takers, family members etc. Intangible costs: for example; emotional/psychosocial burden of job stress, financial hardship, emotional stress caused by health problems and a lower quality of life.

It is the intention of the author that this project serves as a stepping-stone and catalyst, for future management academic investigation into cost effective solutions to the global employee MSD epidemic, that will help organizations' future leaders, employees, employers and managers, to live more healthy and productive lives. It is also the authors' sincere and profoundly deep life objective, that policy makers will someday understand and appreciate the seriousness of poor posture on employee health. This study demonstrated a very high statistical correlation between several clinical findings such as abnormal cervical spine curvature and forward head posture and productivity losses, thus making postural evaluation an important component of an organizations' mandatory health risk assessment processes. The current best practices for health screenings include; cholesterol screenings, blood pressure and blood sugar screenings as well as chest x-ray, to rule out potential health risks such as; heart disease, diabetes and other cardiovascular diseases, which may or may not impact employee health and performance during an employees' working years. MSDs have a statistically significant and profound impact on employee performance, health and productivity during their working years, yet appear to be overlooked as a health risk. Organizations, private and public, must think differently, if they want to achieve better employee health outcomes and increased employee productivity, which translate into greater monetary savings and retained earnings.

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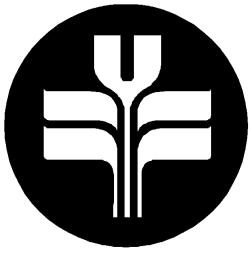
APPENDIX:

Item 1: WLQ Original Questionnaire with Raw Data Results:

Portuguese version used for the study. Copyright protection was built into the documents, making it difficult to copy in the proper format.

Work Limitations Questionnaire©

Self-Administered Long-Form



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Universidade Europeia
LAUREATE INTERNATIONAL UNIVERSITIES

Caro Participante,

O meu nome é Dr. Andrew P. Hatch e sou candidato de Doutoramento na Universidade Europeia.

Gostava de contar com a sua disponibilidade para responder a este questionário e dar a sua opinião sobre as nossas clínicas On-Site (no local de trabalho) ou Off-Site (clínica aberta ao público – Sacavém). O questionário demora no máximo 5 minutos.

Os dados recolhidos serão de grande utilidade para analisar os benefícios e o impacto organizacional resultante dos cuidados de saúde providenciados aos colaboradores, no que refere às condições musculoesqueléticas tais como dores lombares e dores cervicais no local de trabalho.

Obrigado,

Dr. Andrew P. Hatch

Nota: Os dados recolhidos são anónimos e tratados confidencialmente (não haverá perguntas de identificação pessoal). Os dados não serão vendidos ou entregues a terceiros.

Questionário sobre limitações de trabalho ©

Formulário longo de autoavaliação

As perguntas de 1 a 5 referem-se a como a sua saúde afetou o seu desempenho no trabalho nas últimas 2 semanas. Responda às perguntas mesmo no caso de ter faltado alguns dias.

- Assinale a opção «Não se aplica ao meu trabalho» se a pergunta descrever uma tarefa que não faz parte do seu trabalho.
- Se tiver mais de um emprego, responda referindo-se apenas ao seu emprego principal.

1) Estas perguntas referem-se às dificuldades que possa ter sentido no trabalho.
   a) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam trabalhar o número de horas exigidas?

i) Difícil sempre (100 %)
ii) Difícil quase sempre
iii) Difícil parte do tempo (cerca de 50 %)
iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

b) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam funcionar bem logo nas primeiras horas do dia de trabalho?
i) Difícil sempre (100 %)
ii) Difícil quase sempre
iii) Difícil parte do tempo (cerca de 50 %)
iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

c) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam começar a trabalhar assim que chega ao local de trabalho?
i) Difícil sempre (100 %)
ii) Difícil quase sempre
iii) Difícil parte do tempo (cerca de 50 %)
iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

d) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam executar o seu trabalho sem parar para fazer pausas ou descansar?
i) Difícil sempre (100 %)
ii) Difícil quase sempre
iii) Difícil parte do tempo (cerca de 50 %)
iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

e) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam cumprir uma rotina ou horário?
i) Difícil sempre (100 %)
ii) Difícil quase sempre
iii) Difícil parte do tempo (cerca de 50 %)
iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

2) Estas perguntas pedem-lhe para classificar o número de vezes que foi capaz de lidar com determinadas tarefas do seu trabalho sem dificuldade.

a) Nas últimas 2 semanas, quantas vezes foi capaz de caminhar ou deslocar-se até diferentes locais de trabalho (por exemplo, ir a reuniões) sem dificuldade causada por saúde física ou problemas emocionais?
   i) Capaz sempre (100 %)
   ii) Capaz quase sempre
   iii) Capaz parte do tempo (cerca de 50 %)
   iv) Capaz uma pequena parte do tempo
   v) Capaz nunca (0 %)
   vi) Não se aplica ao meu trabalho

b) Nas últimas 2 semanas, quantas vezes foi capaz de levantar, transportar ou deslocar objetos no local de trabalho com mais de 4,5 kg, sem dificuldade causada por saúde física ou problemas emocionais?
   i) Capaz sempre (100 %)
   ii) Capaz quase sempre
   iii) Capaz parte do tempo (cerca de 50 %)
   iv) Capaz uma pequena parte do tempo
   v) Capaz nunca (0 %)
   vi) Não se aplica ao meu trabalho

c) Nas últimas 2 semanas, quantas vezes foi capaz de se sentar, levantar ou ficar na mesma posição durante mais de 15 minutos durante o trabalho sem dificuldade causada por saúde física ou problemas emocionais?
   i) Capaz sempre (100 %)
   ii) Capaz quase sempre
   iii) Capaz parte do tempo (cerca de 50 %)
   iv) Capaz uma pequena parte do tempo
   v) Capaz nunca (0 %)
   vi) Não se aplica ao meu trabalho

d) Nas últimas 2 semanas, quantas vezes foi capaz de repetir os mesmos movimentos vezes sem conta durante o trabalho, sem dificuldade causada por saúde física ou problemas emocionais?
   i) Capaz sempre (100 %)
   ii) Capaz quase sempre
   iii) Capaz parte do tempo (cerca de 50 %)
   iv) Capaz uma pequena parte do tempo
   v) Capaz nunca (0 %)
   vi) Não se aplica ao meu trabalho

e) Nas últimas 2 semanas, quantas vezes foi capaz de se dobrar, torcer ou esticar-se para alcançar algo durante o trabalho, sem dificuldade causada por saúde física ou problemas emocionais?
   i) Capaz sempre (100 %)
   ii) Capaz quase sempre
   iii) Capaz parte do tempo (cerca de 50 %)
   iv) Capaz uma pequena parte do tempo
   v) Capaz nunca (0 %)
   vi) Não se aplica ao meu trabalho

f) Nas últimas 2 semanas, quantas vezes foi capaz de usar instrumentos manuais ou equipamentos (por exemplo, telefone, teclado, rato do computador, berbequim, secador ou lixadeira) sem dificuldade causada por saúde física ou problemas emocionais?
   i) Capaz sempre (100 %)
   ii) Capaz quase sempre
   iii) Capaz parte do tempo (cerca de 50 %)
   iv) Capaz uma pequena parte do tempo
   v) Capaz nunca (0 %)
   vi) Não se aplica ao meu trabalho

3) Estas perguntas referem-se às dificuldades que possa ter sentido no trabalho.

a) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam manter a atenção no seu trabalho?
   i) Difícil sempre (100 %)
   ii) Difícil quase sempre
   iii) Difícil parte do tempo (cerca de 50 %)
   iv) Difícil uma pequena parte do tempo
   v) Não foi difícil (0 %)
   vi) Não se aplica ao meu trabalho

b) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam pensar de forma clara durante o trabalho?
   i) Difícil sempre (100 %)
   ii) Difícil quase sempre
   iii) Difícil parte do tempo (cerca de 50 %)
   iv) Difícil uma pequena parte do tempo
   v) Não foi difícil (0 %)
   vi) Não se aplica ao meu trabalho

c) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam realizar o seu trabalho cuidadosamente?
   i) Difícil sempre (100 %)
   ii) Difícil quase sempre
   iii) Difícil parte do tempo (cerca de 50 %)

iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

d) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam concentrar-se no seu trabalho?
i) Difícil sempre (100 %)
ii) Difícil quase sempre
iii) Difícil parte do tempo (cerca de 50 %)
iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

e) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam trabalhar sem perder a linha de raciocínio?
i) Difícil sempre (100 %)
ii) Difícil quase sempre
iii) Difícil parte do tempo (cerca de 50 %)
iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

f) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam ler com facilidade ou usar os olhos durante o trabalho?
i) Difícil sempre (100 %)
ii) Difícil quase sempre
iii) Difícil parte do tempo (cerca de 50 %)
iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

4) As seguintes perguntas referem-se às dificuldades sentidas no relacionamento com as pessoas com quem contacta no trabalho. Nomeadamente, funcionários, supervisores, colegas, clientes, clientela ou público.

a) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam falar com pessoas pessoalmente, em reuniões ou ao telefone?
i) Difícil sempre (100 %)
ii) Difícil quase sempre
iii) Difícil parte do tempo (cerca de 50 %)
iv) Difícil uma pequena parte do tempo
v) Não foi difícil (0 %)
vi) Não se aplica ao meu trabalho

b) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam controlar o seu temperamento na relação com as pessoas durante o trabalho?
   i) Difícil sempre (100 %)
   ii) Difícil quase sempre
   iii) Difícil parte do tempo (cerca de 50 %)
   iv) Difícil uma pequena parte do tempo
   v) Não foi difícil (0 %)
   vi) Não se aplica ao meu trabalho

c) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam ajudar as outras pessoas a completarem tarefas?
   i) Difícil sempre (100 %)
   ii) Difícil quase sempre
   iii) Difícil parte do tempo (cerca de 50 %)
   iv) Difícil uma pequena parte do tempo
   v) Não foi difícil (0 %)
   vi) Não se aplica ao meu trabalho

5) Estas perguntas referem-se a como corre o trabalho de forma geral.
   a) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam lidar com a carga de trabalho?
      i) Difícil sempre (100 %)
      ii) Difícil quase sempre
      iii) Difícil parte do tempo (cerca de 50 %)
      iv) Difícil uma pequena parte do tempo
      v) Não foi difícil (0 %)
      vi) Não se aplica ao meu trabalho

   b) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam trabalhar suficientemente rápido?
      i) Difícil sempre (100 %)
      ii) Difícil quase sempre
      iii) Difícil parte do tempo (cerca de 50 %)
      iv) Difícil uma pequena parte do tempo
      v) Não foi difícil (0 %)
      vi) Não se aplica ao meu trabalho

   c) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam terminar o trabalho a tempo?
      i) Difícil sempre (100 %)
      ii) Difícil quase sempre
      iii) Difícil parte do tempo (cerca de 50 %)
      iv) Difícil uma pequena parte do tempo
      v) Não foi difícil (0 %)

vi) Não se aplica ao meu trabalho

d) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam fazer o seu trabalho sem cometer erros?
   i) Difícil sempre (100 %)
   ii) Difícil quase sempre
   iii) Difícil parte do tempo (cerca de 50 %)
   iv) Difícil uma pequena parte do tempo
   v) Não foi difícil (0 %)
   vi) Não se aplica ao meu trabalho

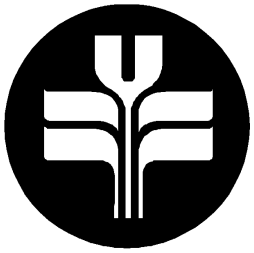
e) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam sentir que fez o que é capaz de fazer?
   i) Difícil sempre (100 %)
   ii) Difícil quase sempre
   iii) Difícil parte do tempo (cerca de 50 %)
   iv) Difícil uma pequena parte do tempo
   v) Não foi difícil (0 %)
   vi) Não se aplica ao meu trabalho

Item 2: WLQ original 25 question English version:

CONFIDENTIAL

Work Limitations Questionnaire©

Self-Administered Long-Form



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Month Day
Yea

Instructions

Health problems can make it difficult for working people to perform certain parts of their jobs. We are interested in learning about how your health may have affected you at work during the past 2 weeks.

(1) The questions will ask you to think about your physical health or emotional problems. These refer to any ongoing or permanent medical conditions you may have and the effects of any treatments you are taking for these. Emotional problems may include feeling depressed or anxious.

(2) Most of the questions are multiple choice. They ask you to answer by placing a mark in a box.
For example:

How satisfied are you with each of the following . . .?

(Mark one box on each line a. and b.)

	Not At All Satisfied	Moderately Satisfied	Very Satisfied
Your local schools.	☐1	☐2	■3
Your local police department. . .	☐1	■2	☐3

3. Before you begin answering any questions, we would like you to write some information on the calendar.

- Find today's date. Mark that box.
- Count back 2 weeks and mark that box too.

This 2-week period is the subject of most of the questions. Feel free to mark other important dates such as birthdays, family events, or work deadlines. Please use the calendar to help you answer correctly.

Questions 1 through 5 ask about how your health has affected you at work during the past 2 weeks. Please answer these questions even if you missed some workdays.

- *Mark the "Does not apply to my job" box only if the question describes something that is not part of your job.*
- *If you have more than one job, report on your **main** job only.*

1. In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?

(*Mark one box on each line a. through e.*)

	Difficult all of the time (100%)	**Difficult** most of the time	**Difficult** some of the time (about 50%)	**Difficult** a slight bit of the time	**Difficult** none of the time (0%)	Does not apply to my job
work the required number of hours	☐1	☐2	☐3	☐4	☐5	☐6
get going easily at the beginning of the workday	☐1	☐2	☐3	☐4	☐5	☐6
start on your job as soon as you arrived at work	☐1	☐2	☐3	☐4	☐5	☐6
do your work without stopping to take breaks or rests	☐1	☐2	☐3	☐4	☐5	☐6
stick to a routine or schedule	☐1	☐2	☐3	☐4	☐5	☐6

PLEASE READ CAREFULLY

These questions ask you to rate the amount of time you were able to handle certain parts of your job without difficulty.

2. a. In the past 2 weeks, how much of the time were you **able** to walk or move around different work locations (for example, go to meetings), without difficulty caused by physical health or emotional problems?

(*Mark one box.*)

Able all of the time (100%)	☐1
Able most of the time	☐2
Able some of the time (about 50%)	☐3
Able a slight bit of the time	☐4
Able none of the time (0%)	☐5
Does not apply to my job	☐6

b. In the past 2 weeks, how much of the time were you **able** to lift, carry, or move objects at work weighing more than 10 lbs., without difficulty caused by physical health or emotional problems (*Mark one box.*)

Able all of the time (100%)	☐1
Able most of the time	☐2
Able some of the time (about 50%)	☐3
Able a slight bit of the time	☐4
Able none of the time (0%)	☐5
Does not apply to my job	☐6

c. In the past 2 weeks, how much of the time were you **able** to sit, stand, or stay in one position for longer than 15 minutes while working, without difficulty caused by physical health or emotional problems? (*Mark one box.*)

Able all of the time (100%)	☐1
Able most of the time	☐2
Able some of the time (about 50%)	☐3

Able a slight bit of the time	☐4
Able none of the time (0%)	☐5
Does not apply to my job	☐6

d. In the past 2 weeks, how much of the time were you **able** to repeat the same motions over and over again while working, without difficulty caused by physical health or emotional problems?
(*Mark one box.*)

Able all of the time (100%)	☐1
Able most of the time	☐2
Able some of the time (about 50%)	☐3
Able a slight bit of the time	☐4
Able none of the time (0%)	☐5
Does not apply to my job	☐6

e In the past 2 weeks, how much of the time were you **able** to bend, twist, or reach while working, without difficulty caused by physical health or emotional problems?

(*Mark one box.*)

Able all of the time (100%)	☐1
Able most of the time	☐2
Able some of the time (about 50%)	☐3
Able a slight bit of the time	☐4
Able none of the time (0%)	☐5
Does not apply to my job	☐6

f In the past 2 weeks, how much of the time were you **able** to use hand-held tools or equipment (e.g., a phone, pen, keyboard, computer mouse, drill, hairdryer, or sander), without difficulty caused by physical health or emotional problems?

(*Mark one box.*)

Able all of the time (100%)	☐1
Able most of the time	☐2
Able some of the time (about 50%)	☐3
Able a slight bit of the time	☐4
Able none of the time (0%)	☐5
Does not apply to my job	☐6

PLEASE READ CAREFULLY

These questions ask about difficulties you may have had at work.

3. In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?

(Mark one box on each line a. through f.)

	Difficult all of the time (100%)	**Difficult** most of the time	**Difficult** some of the time (about 50%)	**Difficult** a slight bit of the time	**Difficult** none of the time (0%)	Does not apply to my job
a. keep your mind on your work	☐1	☐2	☐3	☐4	☐5	☐6
b. think clearly when working	☐1	☐2	☐3	☐4	☐5	☐6
c. do work carefully	☐1	☐2	☐3	☐4	☐5	☐6
d. concentrate on your work	☐1	☐2	☐3	☐4	☐5	☐6

e. work without losing your train of thought	☐1	☐2	☐3	☐4	☐5	☐6
f. easily read or use your eyes when working	☐1	☐2	☐3	☐4	☐5	☐6

The next questions ask about difficulties in relation to the people you came in contact with while working. These may include employers, supervisors, coworkers, clients, customers, or the public.

4. In the past 2 weeks, how much of the time did your physical health or emotional problems make it difficult for you to do the following?

(Mark one box on each line a. through c.)

	Difficult all of the time (100%)	**Difficult** most of the time	**Difficult** some of the time (about 50%)	**Difficult** a slight bit of the time	**Difficult** none of the time (0%)	Does not apply to my job
a. speak with people in-person, in meetings or on the phone	☐1	☐2	☐3	☐4	☐5	☐6
b. control your temper around people when working	☐1	☐2	☐3	☐4	☐5	☐6
c. help other people to get work done	☐1	☐2	☐3	☐4	☐5	☐6

These questions ask about how things went at work overall.

6. In the <u>past 2 weeks</u>, how much of the time did your physical health or emotional problems make it difficult for you to do the following?
(Mark one box on each line a. through e.)

	Difficult all of the time (100%)	**Difficult** most of the time	**Difficult** some of the time (about 50%)	**Difficult** a slight bit of the time	**Difficult** none of the time (0%)	Does not apply to my job
a. handle the workload	☐1	☐2	☐3	☐4	☐5	☐6
b. work fast enough	☐1	☐2	☐3	☐4	☐5	☐6
c. finish work on time	☐1	☐2	☐3	☐4	☐5	☐6
d. do your work without making mistakes	☐1	☐2	☐3	☐4	☐5	☐6
e. feel you've done what you are capable of doing	☐1	☐2	☐3	☐4	☐5	☐6

Item 3: WLQ Questionnaire and Phase 1 Results, Portuguese On-Line Version:

1) Estas perguntas referem-se às dificuldades que possa ter sentido no trabalho.

a) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam trabalhar o número de horas exigidas?
277 de 277 pessoas responderam esta pergunta

i) Difícil parte do tempo (cerca de 50 %)	123 / 44%
ii) Difícil quase sempre	72 / 26%
iii) Difícil uma pequena parte do tempo	61 / 22%
iv) Difícil sempre (100 %)	15 / 5%
v) Não foi difícil (0 %)	6 / 2%
vi) Não se aplica ao meu trabalho	0 / 0%

b) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam funcionar bem logo nas primeiras horas do dia de trabalho?
277 de 277 pessoas responderam esta pergunta

i) Difícil uma pequena parte do tempo	101 / 36%
ii) Difícil parte do tempo (cerca de 50 %)	90 / 32%
iii) Difícil quase sempre	53 / 19%
iv) Não foi difícil (0 %)	32 / 12%
v) Difícil sempre (100 %)	1 / 0%
vi) Não se aplica ao meu trabalho	0 / 0%

c) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam começar a trabalhar assim que chega ao local de trabalho?
277 de 277 pessoas responderam esta pergunta

i) Difícil uma pequena parte do tempo	102 / 37%
ii) Difícil parte do tempo (cerca de 50 %)	91 / 33%
iii) Difícil quase sempre	47 / 17%
iv) Não foi difícil (0 %)	36 / 13%
v) Difícil sempre (100 %)	1 / 0%
vi) Não se aplica ao meu trabalho	0 / 0%

d) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam executar o seu trabalho sem parar para fazer pausas ou descansar?
277 de 277 pessoas responderam esta pergunta

i) Difícil quase sempre	114 / 41%
ii) Difícil parte do tempo (cerca de 50 %)	100 / 36%
iii) Difícil uma pequena parte do tempo	34 / 12%

iv) Difícil sempre (100 %) 26 / 9%
v) Não foi difícil (0 %) 3 / 1%
vi) Não se aplica ao meu trabalho 0 / 0%

e) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam cumprir uma rotina ou horário?
277 de 277 pessoas responderam esta pergunta

i) Difícil uma pequena parte do tempo 120 / 43%
ii) Difícil parte do tempo (cerca de 50 %) 101 / 36%
iii) Difícil quase sempre 37 / 13%
iv) Não foi difícil (0 %) 18 / 6%
v) Difícil sempre (100 %) 1 / 0%
vi) Não se aplica ao meu trabalho 0 / 0%

2) Estas perguntas pedem-lhe para classificar o número de vezes que foi capaz de lidar com determinadas tarefas do seu trabalho sem dificuldade.

a) Nas últimas 2 semanas, quantas vezes foi capaz de caminhar ou deslocar-se até diferentes locais de trabalho (por exemplo, ir a reuniões) sem dificuldade causada por saúde física ou problemas emocionais?
277 de 277 pessoas responderam esta pergunta

i) Capaz parte do tempo (cerca de 50 %) 86 / 31%
ii) Capaz quase sempre 70 / 25%
iii) Capaz uma pequena parte do tempo 58 / 21%
iv) Capaz sempre (100 %) 48 / 17%
v) Capaz nunca (0 %) 15 / 5%
vi) Não se aplica ao meu trabalho 0 / 0%

b) Nas últimas 2 semanas, quantas vezes foi capaz de levantar, transportar ou deslocar objetos no local de trabalho com mais de 4,5 kg, sem dificuldade causada por saúde física ou problemas emocionais?
277 de 277 pessoas responderam esta pergunta

i) Não se aplica ao meu trabalho 93 / 34%
ii) Capaz parte do tempo (cerca de 50 %) 64 / 23%
iii) Capaz quase sempre 61 / 22%
iv) Capaz uma pequena parte do tempo 27 / 10%
v) Capaz sempre (100 %) 21 / 8%
vi) Capaz nunca (0 %) 11 / 4%

c) Nas últimas 2 semanas, quantas vezes foi capaz de se sentar, levantar ou ficar na mesma posição durante mais de 15 minutos durante o trabalho sem dificuldade causada por saúde física ou problemas emocionais?

277 de 277 pessoas responderam esta pergunta

i) Capaz uma pequena parte do tempo 103 / 37%
ii) Capaz parte do tempo (cerca de 50 %) 84 / 30%
iii) Capaz nunca (0 %) 60 / 22%
iv) Capaz quase sempre 26 / 9%
v) Capaz sempre (100 %) 4 / 1%
vi) Não se aplica ao meu trabalho 0 / 0%

d) Nas últimas 2 semanas, quantas vezes foi capaz de repetir os mesmos movimentos vezes sem conta durante o trabalho, sem dificuldade causada por saúde física ou problemas emocionais?
277 de 277 pessoas responderam esta pergunta

i) Capaz parte do tempo (cerca de 50 %) 148 / 53%
ii) Capaz quase sempre 65 / 23%
iii) Capaz uma pequena parte do tempo 46 / 17%
iv) Capaz sempre (100 %) 12 / 4%
v) Capaz nunca (0 %) 6 / 2%
vi) Não se aplica ao meu trabalho 0 / 0%

e) Nas últimas 2 semanas, quantas vezes foi capaz de se dobrar, torcer ou esticar-se para alcançar algo durante o trabalho, sem dificuldade causada por saúde física ou problemas emocionais?
277 de 277 pessoas responderam esta pergunta

i) Capaz parte do tempo (cerca de 50 %) 81 / 29%
ii) Capaz uma pequena parte do tempo 74 / 27%
iii) Capaz nunca (0 %) 56 / 20%
iv) Capaz quase sempre 47 / 17%
v) Capaz sempre (100 %) 19 / 7%
vi) Não se aplica ao meu trabalho 0 / 0%

f) Nas últimas 2 semanas, quantas vezes foi capaz de usar instrumentos manuais ou equipamentos (por exemplo, telefone, teclado, rato do computador, berbequim, secador ou lixadeira) sem dificuldade causada por saúde física ou problemas emocionais?
277 de 277 pessoas responderam esta pergunta

i) Capaz parte do tempo (cerca de 50 %) 124 / 45%
ii) Capaz quase sempre 77 / 28%
iii) Capaz uma pequena parte do tempo 50 / 18%
iv) Capaz sempre (100 %) 15 / 5%
v) Capaz nunca (0 %) 11 / 4%
vi) Não se aplica ao meu trabalho 0 / 0%

3) Estas perguntas referem-se às dificuldades que possa ter sentido no trabalho.

a) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam manter a atenção no seu trabalho?
277 de 277 pessoas responderam esta pergunta

i)	Difícil uma pequena parte do tempo	148 / 53%
ii)	Difícil parte do tempo (cerca de 50 %)	82 / 30%
iii)	Difícil quase sempre	30 / 11%
iv)	Não foi difícil (0 %)	16 / 6%
v)	Difícil sempre (100 %)	1 / 0%
vi)	Não se aplica ao meu trabalho	0 / 0%

b) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam pensar de forma clara durante o trabalho?
277 de 277 pessoas responderam esta pergunta

i)	Difícil uma pequena parte do tempo	171 / 62%
ii)	Difícil parte do tempo (cerca de 50 %)	61 / 22%
iii)	Não foi difícil (0 %)	30 / 11%
iv)	Difícil quase sempre	14 / 5%
v)	Difícil sempre (100 %)	1 / 0%
vi)	Não se aplica ao meu trabalho	0 / 0%

c) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam realizar o seu trabalho cuidadosamente?
277 de 277 pessoas responderam esta pergunta

i)	Difícil uma pequena parte do tempo	166 / 60%
ii)	Não foi difícil (0 %)	54 / 19%
iii)	Difícil parte do tempo (cerca de 50 %)	47 / 17%
iv)	Difícil quase sempre	10 / 4%
v)	Difícil sempre (100 %)	0 / 0%
vi)	Não se aplica ao meu trabalho	0 / 0%

d) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam concentrar-se no seu trabalho?
277 de 277 pessoas responderam esta pergunta

i)	Difícil uma pequena parte do tempo	158 / 57%
ii)	Difícil parte do tempo (cerca de 50 %)	75 / 27%
iii)	Difícil quase sempre	23 / 8%
iv)	Não foi difícil (0 %)	19 / 7%
v)	Difícil sempre (100 %)	2 / 1%
vi)	Não se aplica ao meu trabalho	0 / 0%

e) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam trabalhar sem perder a linha de raciocínio?
277 de 277 pessoas responderam esta pergunta

i) Difícil uma pequena parte do tempo 164 / 59%
ii) Difícil parte do tempo (cerca de 50 %) 71 / 26%
iii) Não foi difícil (0 %) 28 / 10%
iv) Difícil quase sempre 10 / 4%
v) Difícil sempre (100 %) 4 / 1%
vi) Não se aplica ao meu trabalho 0 / 0%

f) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam ler com facilidade ou usar os olhos durante o trabalho?
277 de 277 pessoas responderam esta pergunta

i) Difícil uma pequena parte do tempo 127 / 46%
ii) Não foi difícil (0 %) 93 / 34%
iii) Difícil parte do tempo (cerca de 50 %) 49 / 18%
iv) Difícil quase sempre 7 / 3%
v) Não se aplica ao meu trabalho 1 / 0%
vi) Difícil sempre (100 %) 0 / 0%

4) As seguintes perguntas referem-se às dificuldades sentidas no relacionamento com as pessoas com quem contacta no trabalho. Nomeadamente, funcionários, supervisores, colegas, clientes, clientela ou público.

a) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam falar com pessoas pessoalmente, em reuniões ou ao telefone?
277 de 277 pessoas responderam esta pergunta

i) Difícil uma pequena parte do tempo 152 / 55%
ii) Difícil parte do tempo (cerca de 50 %) 63 / 23%
iii) Não foi difícil (0 %) 56 / 20%
iv) Difícil quase sempre 6 / 2%
v) Difícil sempre (100 %) 0 / 0%
vi) Não se aplica ao meu trabalho 0 / 0%

b) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam controlar o seu temperamento na relação com as pessoas durante o trabalho?
277 de 277 pessoas responderam esta pergunta

i) Difícil uma pequena parte do tempo 135 / 49%
ii) Não foi difícil (0 %) 71 / 26%
iii) Difícil parte do tempo (cerca de 50 %) 65 / 23%
iv) Difícil quase sempre 5 / 2%
v) Difícil sempre (100 %) 1 / 0%
vi) Não se aplica ao meu trabalho 0 / 0%

c) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam ajudar as outras pessoas a completarem tarefas?
277 de 277 pessoas responderam esta pergunta

i) Difícil uma pequena parte do tempo	132 / 48%
ii) Não foi difícil (0 %)	70 / 25%
iii) Difícil parte do tempo (cerca de 50 %)	63 / 23%
iv) Difícil quase sempre	11 / 4%
v) Difícil sempre (100 %)	1 / 0%
vi) Não se aplica ao meu trabalho	0 / 0%

5) Estas perguntas referem-se a como corre o trabalho de forma geral.

a) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam lidar com a carga de trabalho?
277 de 277 pessoas responderam esta pergunta

i) Difícil parte do tempo (cerca de 50 %)	142 / 51%
ii) Difícil uma pequena parte do tempo	75 / 27%
iii) Difícil quase sempre	41 / 15%
iv) Difícil sempre (100 %)	13 / 5%
v) Não foi difícil (0 %)	6 / 2%
vi) Não se aplica ao meu trabalho	0 / 0%

b) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam trabalhar suficientemente rápido?
277 de 277 pessoas responderam esta pergunta

i) Difícil parte do tempo (cerca de 50 %)	130 / 47%
ii) Difícil uma pequena parte do tempo	90 / 32%
iii) Difícil quase sempre	38 / 14%
iv) Difícil sempre (100 %)	12 / 4%
v) Não foi difícil (0 %)	7 / 3%
vi) Não se aplica ao meu trabalho	0 / 0%

c) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam terminar o trabalho a tempo?
277 de 277 pessoas responderam esta pergunta

i) Difícil uma pequena parte do tempo	124 / 45%
ii) Difícil parte do tempo (cerca de 50 %)	105 / 38%
iii) Difícil quase sempre	24 / 9%
iv) Não foi difícil (0 %)	20 / 7%
v) Difícil sempre (100 %)	4 / 1%
vi) Não se aplica ao meu trabalho	0 / 0%

d) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam fazer o seu trabalho sem cometer erros?
277 de 277 pessoas responderam esta pergunta

i)	Difícil uma pequena parte do tempo	192 / 69%
ii)	Não foi difícil (0 %)	47 / 17%
iii)	Difícil parte do tempo (cerca de 50 %)	30 / 11%
iv)	Difícil quase sempre	7 / 3%
v)	Difícil sempre (100 %)	1 / 0%
vi)	Não se aplica ao meu trabalho	0 / 0%

e) Nas últimas 2 semanas, quantas vezes sentiu que a sua saúde física ou problemas emocionais lhe dificultavam sentir que fez o que é capaz de fazer?
277 de 277 pessoas responderam esta pergunta

i)	Difícil parte do tempo (cerca de 50 %)	140 / 51%
ii)	Difícil uma pequena parte do tempo	90 / 32%
iii)	Difícil quase sempre	29 / 10%
iv)	Difícil sempre (100 %)	11 / 4%
v)	Não foi difícil (0 %)	7 / 3%
vi)	Não se aplica ao meu trabalho	0 / 0%

Item 4 WLQ Raw Data: 25 Tables with Phase 1 and Phase 2 Comparison.
The following tables represent the percentage of the employee population studied who responded to each of the 25 questions in the WLQ for phase 1 and phase 2 of the study. This data was originally provided in Portuguese in a graphic format and translated into the tables below for consistency and clarity.

Item 4.1 Time Management Demands Scale:
1a. Difficulty to work the required number of hours per day:

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment**
Not Difficult (0%)	2%	0%	54.55%
Small part of the time (25%)	22%	6.74%	31.82%
Some of the Time (50%)	44%	29.21%	13.64%
Almost Always (75%)	26%	40.45%	0%
Always (100%)	5%	23.6%	0%

1b. Difficulty to get going easily during the first hours of the work day:

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control**	**Treatment**
Never Difficult (0%)	12%	0%	86.36%
Small part of the time (25%)	36%	23.60%	11.36%
Some of the Time (50%)	32%	43.82%	2.27%
Almost Always (75%)	19%	31.46%	0%
Always (100%)	(1 subject) 0%	1.12%	0%

1c. Difficulty to function upon arrival at work:

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control**	**Treatment**
Never Difficult (0%)	13%	0%	86.36%
Small part of the time (25%)	37%	28.09%	11.36%

Some of the Time (50%)	33%	43.82%	2.27%
Almost Always (75%)	17%	26.97%	0%
Always (100%)	(1 Subject) 0%	1.12%	0%

1d. Difficulty working without taking breaks or rest.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control**	**Treatment**
Never Difficult (0%)	1%	0%	39.77%
Small part of the time (25%)	12%	1.12%	38.64%
Some of the Time (50%)	36%	16.85%	18.18%
Almost Always (75%)	41%	29.21%	3.41%
Always (100%)	9%	52.81%	0%

1e. Difficulty to stick to a routine or schedule.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control**	**Treatment**
Never Difficult (0%)	6%	7.87%	98.86%
Small part of the time (25%)	43%	33.71%	1.14%
Some of the Time (50%)	36%	50.56%	0%
Almost Always (75%)	13%	7.87%	0%
Always (100%)	0%	0%	0%

Item 4.2 Physical Demands Scale.
This measures the subject's ability to perform physical tasks ***WITHOUT*** difficulty. The scale is opposite all the other scales.

2a. Ability to walk or move around different work locations (for example, go to meetings).

	PHASE 1	**PHASE 2**	
% of Time *Without* Difficulty	% of Subjects Replied…	**Control**	**Treatment**
Never Without Difficulty (0%)	17%	19.10%	0%

Small part of the time (25%)	22%	35.96%	1.14%
Part of the Time (50%)	31%	24.72%	5.68%
Almost Always (75%)	25%	10.11%	22.73%
Always (100%)	5%	10.11%	70.45%

2b. Ability to lift, carry and move objects that weigh over 4.5 kilos without difficulty.

	PHASE 1	**PHASE 2**	
% of Time *Without* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Without Difficulty (0%)	4%	24.72%	0%
Small part of the time (25%)	10%	39.33%	0%
Part of the Time (50%)	23%	22.47%	9.09%
Almost Always (75%)	22%	8.99%	34.09%
Always (100%)	8%	4.49%	56.82%

2c. Ability to sit in one position for longer than 15 minutes while working without difficulty.

	PHASE 1	**PHASE 2**	
% of Time *Without* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Without Difficulty (0%)	22%	65.17%	0%
Small part of the time (25%)	37%	17.98%	2.27%
Part of the Time (50%)	30%	11.24%	19.32%
Almost Always (75%)	9%	1.12%	26.14%
Always (100%)	1%	0%	0%

2d. Ability to make repetitive movements while working without difficulty.

	PHASE 1	**PHASE 2**	
% of Time *Without* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Without Difficulty (0%)	2%	8.99%	0%

Small part of the time (25%)	17%	26.97%	3.41%
Part of the Time (50%)	53%	49.44%	12.50%
Almost Always (75%)	23%	14.61%	26.14%
Always (100%)	4%	0%	57.95%

2e. Ability to bend, twist or reach while working without difficulty.

	PHASE 1	**PHASE 2**	
% of Time *Without* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Without Difficult (0%)	20%	49.44%	0%
Small part of the time (25%)	27%	24.72%	2.27%
Part of the Time (50%)	29%	14.61%	15.91%
Almost Always (75%)	17%	6.74%	38.64%
Always (100%)	7%	4.49%	43.18%

2f. Ability to use hand-held tools or equipment (e.g., phone, pen, keyboard, computer mouse, drill, hairdryer, or sander), without difficulty.

	PHASE 1	**PHASE 2**	
% of Time *Without* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Without Difficult (0%)	4%	6.74%	0%
Small part of the time (25%)	18%	14.61%	1.14%
Part of the Time (50%)	45%	60.67%	11.36%
Almost Always (75%)	28%	17.98%	25%
Always (100%)	5%	0%	62.50%

Item 4.3 Mental and Interpersonal Tasks Scale, Part 1.
This question reverts to "with difficulty".

3a. Ability to keep their mind on their work during the day.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	6%	4.49%	82.95%
Small part of the time (25%)	53%	42.70%	17.05%
Part of the Time (50%)	30%	49.44%	0%
Almost Always (75%)	11%	3.37%	0%
Always (100%)	0%	0%	0%

3b. Ability to think clearly when working.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	11%	10.11%	97.73%
Small part of the time (25%)	62%	44.94%	2.27%
Part of the Time (50%)	22%	42.70%	0%
Almost Always (75%)	5%	2.25%	0%
Always (100%)	0%	0%	0%

3c. Ability to work carefully.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	19%	24.72%	98.86%
Small part of the time (25%)	60%	49.44%	1.14%
Part of the Time (50%)	17%	25.84%	0%
Almost Always (75%)	4%	0%	0%
Always (100%)	0%	0%	0%

3d. Ability to concentrate on your work.

	PHASE 1	PHASE 2	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	7%	6.74%	88.64%
Small part of the time (25%)	57%	50.56%	11.36%
Part of the Time (50%)	27%	37.08%	0%
Almost Always (75%)	8%	5.62%	0%
Always (100%)	1%	0%	0%

3e. Ability to work without losing your line of thought.

	PHASE 1	PHASE 2	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	10%	17,98%	96.59%
Small part of the time (25%)	59%	48.31%	3.41%
Part of the Time (50%)	26%	31.46%	0%
Almost Always (75%)	4%	2.25%	0%
Always (100%)	1%	0%	0%

3f. Ability to read or use their eyes when working.

	PHASE 1	PHASE 2	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	34%	40.45%	98.86%
Small part of the time (25%)	46%	55.06%	1.14%
Part of the Time (50%)	18%	4.49%	0%
Almost Always (75%)	3%	0%	0%
Always (100%)	0%	0%	0%

Item 4.4 Mental and Interpersonal Tasks Scale, Part 2.

4a. Ability to speak with people in-person, in meetings or on the phone.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	20%	24.72%	94.32%
Small part of the time (25%)	55%	49.44%	5.68%
Part of the Time (50%)	23%	25.84%	0%
Almost Always (75%)	2%	0%	0%
Always (100%)	0%	0%	0%

4b. Ability to control temper around people at work.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	26%	25.84%	95.45%
Small part of the time (25%)	49%	51.69%	4.55%
Part of the Time (50%)	23%	22.47%	0%
Almost Always (75%)	2%	0%	0%
Always (100%)	0%	0%	0%

4c. Ability to help other people get work done.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	25%	33.71%	95.45%
Small part of the time (25%)	48%	52.81%	4.55%
Part of the Time (50%)	23%	13.48%	0%
Almost Always (75%)	4%	0%	0%
Always (100%)	0%	0%	0%

Item 4.5 Work Output Ability Scale.

5a. Ability to handle the daily workload.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	2%	3.37%	65.91%
Small part of the time (25%)	27%	14.61%	29.55%
Part of the Time (50%)	51%	48.31%	4.55%
Almost Always (75%)	15%	33.71%	0%
Always (100%)	5%	0%	0%

5b. Ability to work fast enough.

	PHASE 1	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	3%	2.25%	75%
Small part of the time (25%)	32%	15.73%	20.45%
Part of the Time (50%)	47%	48.31%	4.55%
Almost Always (75%)	14%	33.71%	0%
Always (100%)	4%	0%	0%

5c. Ability to finish work on time.

	PHASE 2	**PHASE 2**	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	7%	1.12%	67.05%
Small part of the time (25%)	45%	16.85%	28.41%
Part of the Time (50%)	38%	47.19%	4.55%
Almost Always (75%)	9%	0%	0%
Always (100%)	1%	0%	0%

5d. Ability to do work without making mistakes

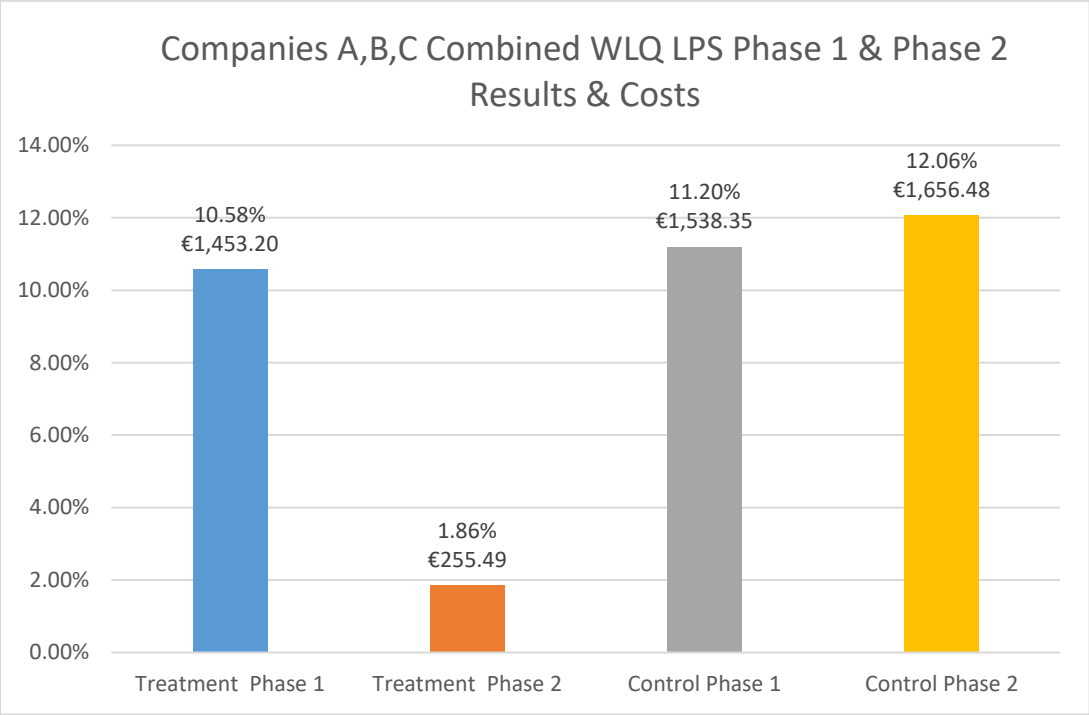
	PHASE 1	PHASE 2	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	17%	21.35%	97.73%
Small part of the time (25%)	69%	65.17%	2.27%
Part of the Time (50%)	11%	13.48%	0%
Almost Always (75%)	3%	0%	0%
Always (100%)	0%	0%	0%

5e. Difficulty doing what you are capable of doing for work.

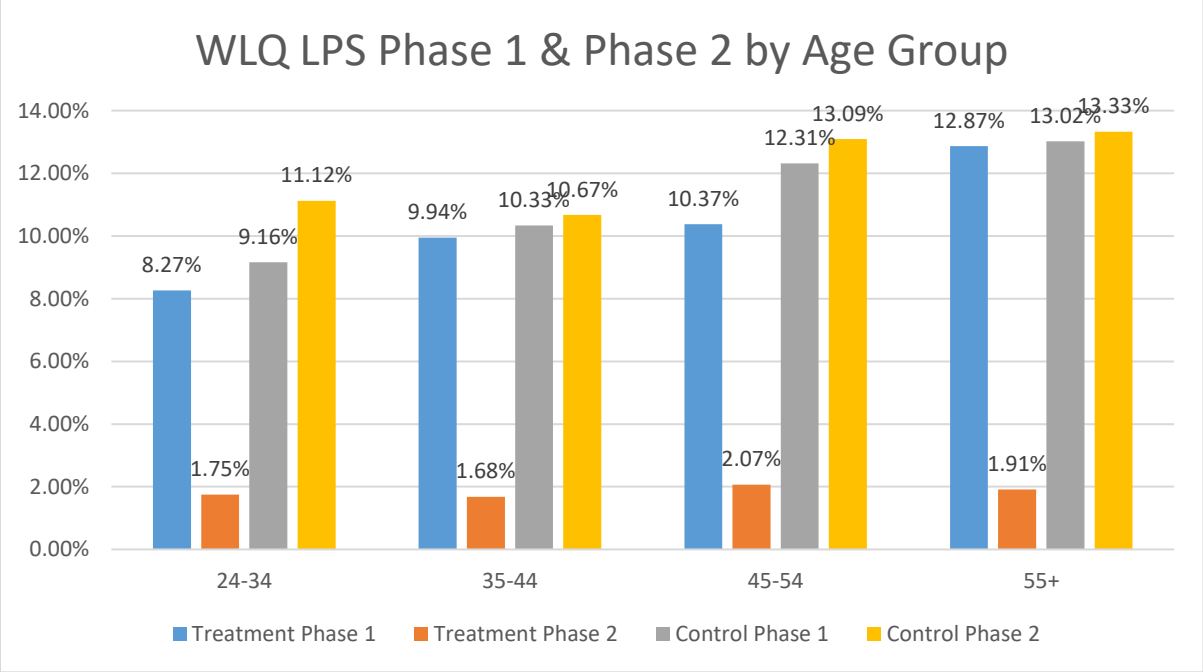
	PHASE 1	PHASE 2	
% of Time *With* Difficulty	% of Subjects Replied…	**Control Group**	**Treatment Group**
Never Difficult (0%)	3%	0%	64.77%
Small part of the time (25%)	32%	12.36%	31.82%
Part of the Time (50%)	51%	47.19%	3.41%
Almost Always (75%)	10%	40.45%	0%
Always (100%)	4%	0%	0%

Item 5 WLQ LPS Graphical Presentations:

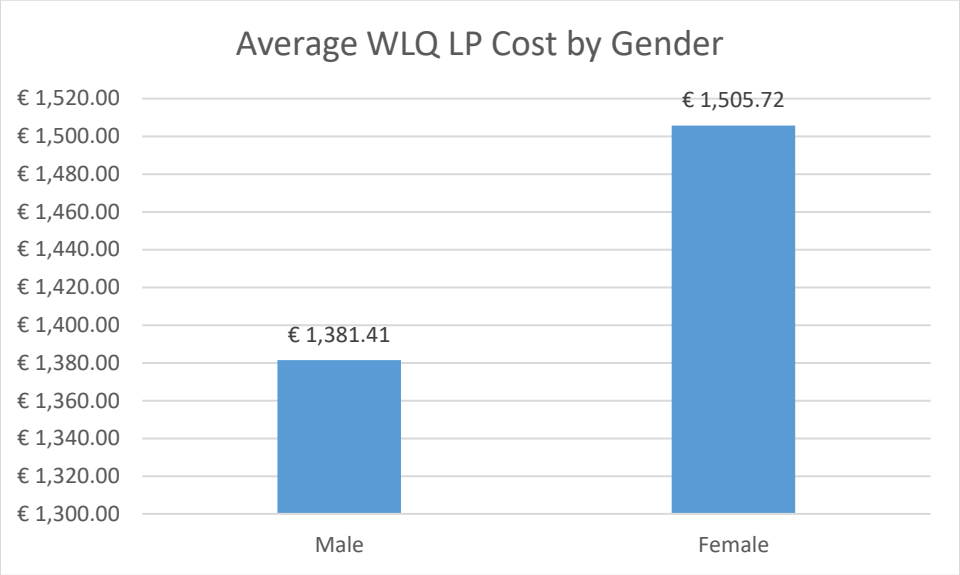
Item 5.1 WLQ LPS Phase 1 & 2 with Associated Costs, Companies A, B, C combined.



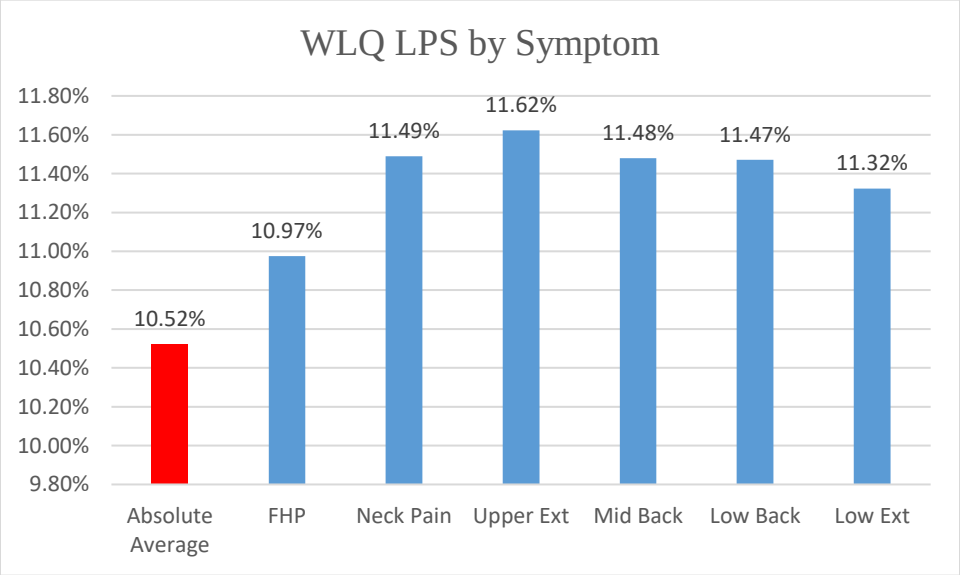
Item 5.2 WLQ LPS Phase 1 & 2 by Age Group.



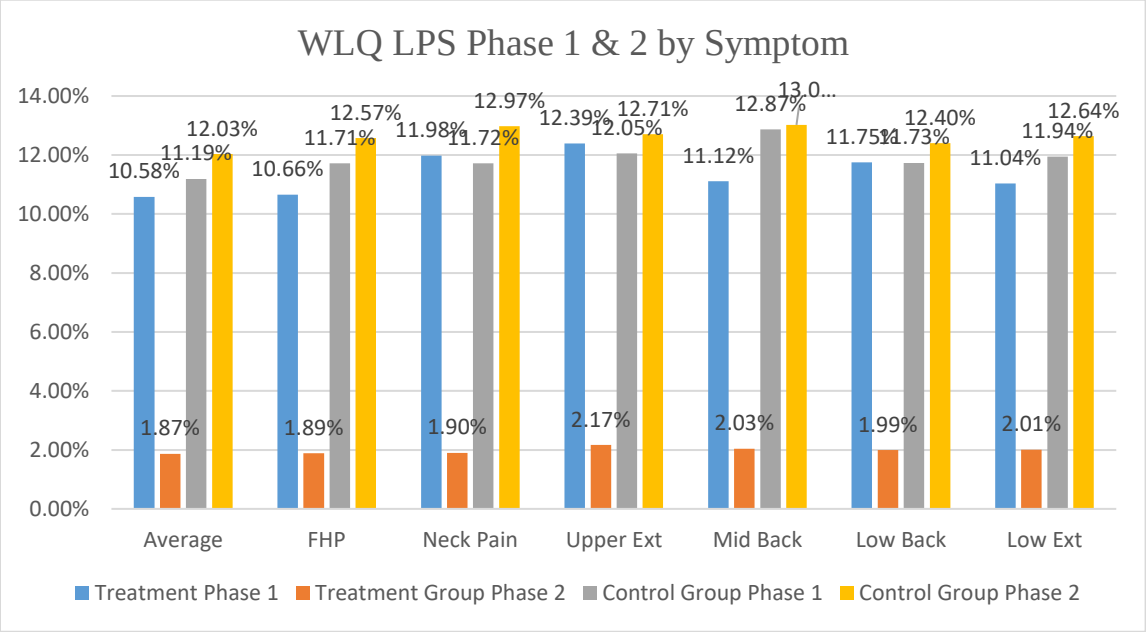
Item 5.3 Average WLQ LPS, Cost by Gender



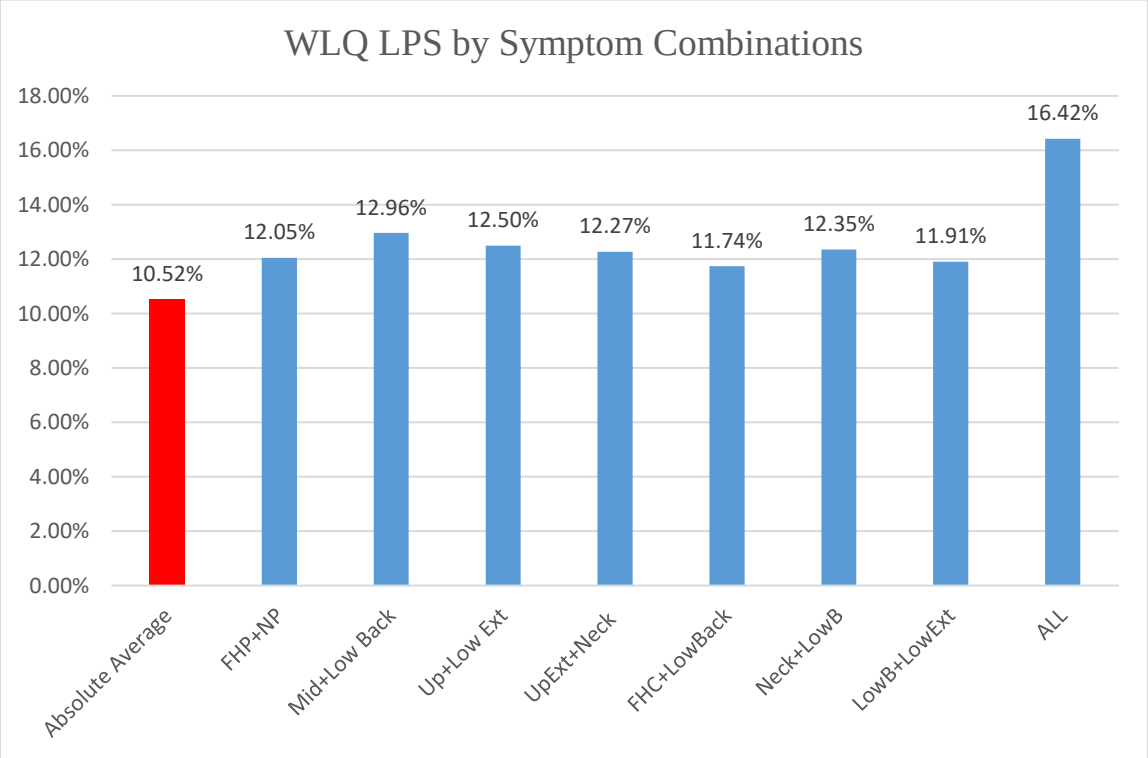
Item 5.4 WLQ Score by SYMPTOMS: Phase 1:



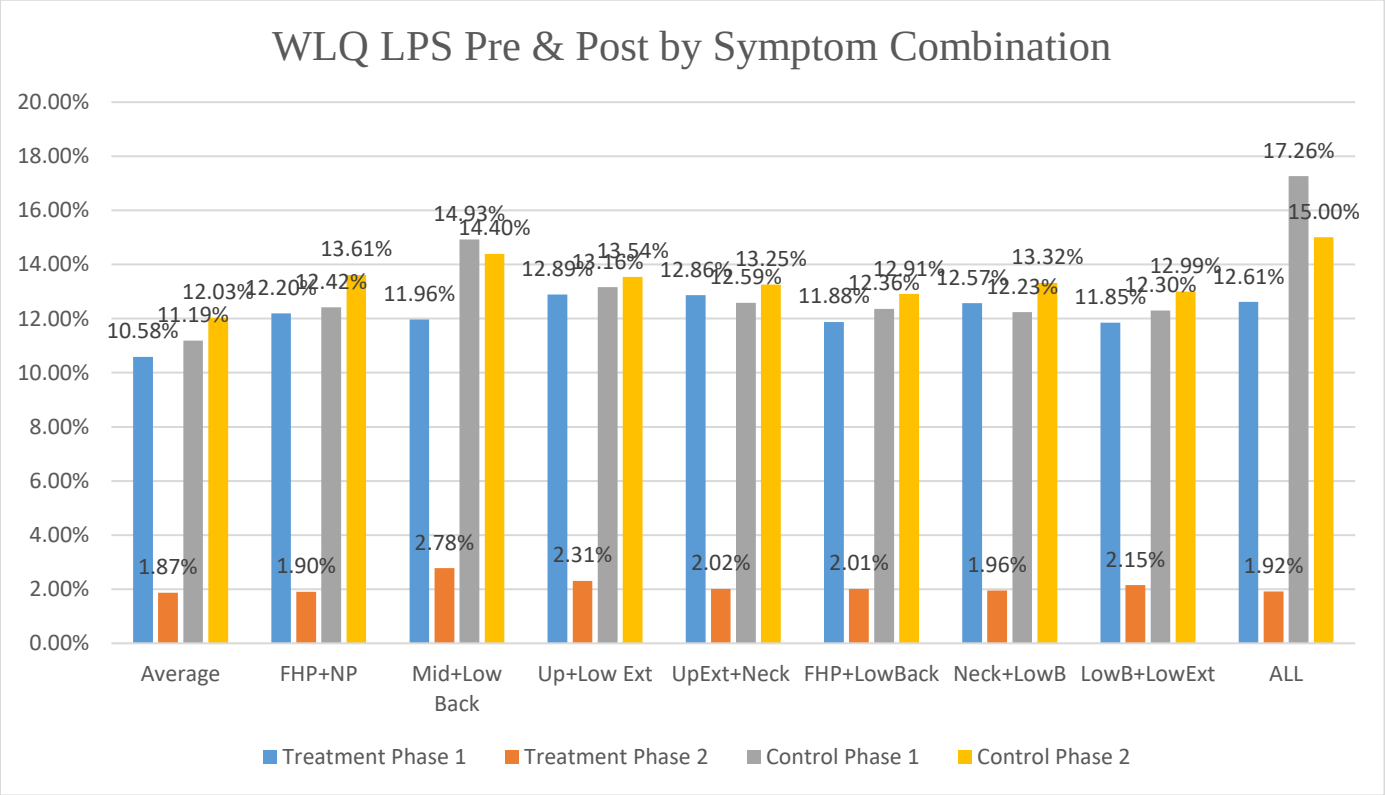
Item 5.5 WLQ LPS by Symptoms: Phase 1 & 2 with Control



Item 5.6 WLQ LPS by Symptom Combinations: Phase 1



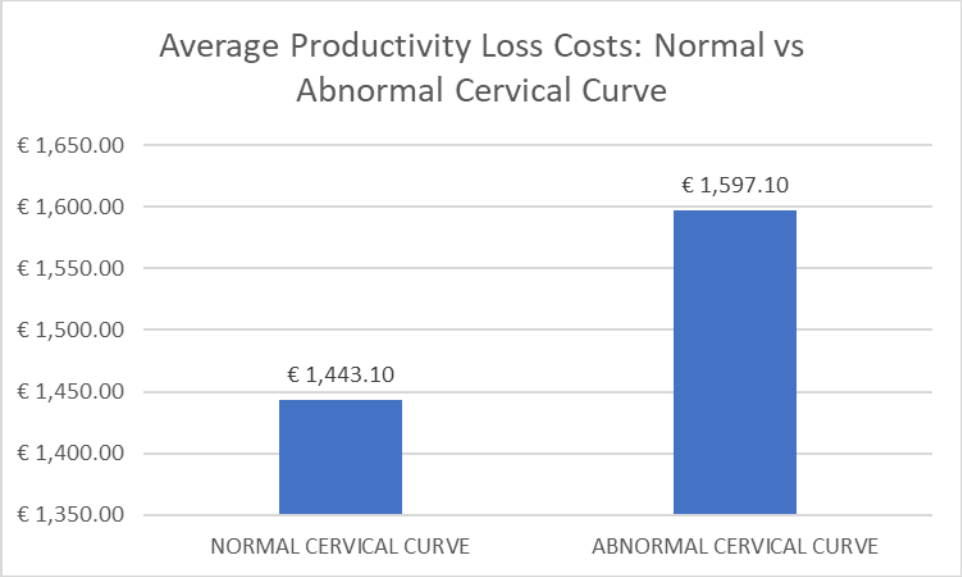
Item 5.7 WLQ LPS by Symptom Combinations: Phase 1 & 2 with Control



Item 5.8 WLQ Lost Productivity Cost Comparison: Normal vs Abnormal Cervical Curve, Cost Per Case, Per Year.

It is worth noting that 95% of the subjects presented with Abnormal Cervical Spine Curve. Only 5% presented with a Normal Cervical Spine Curve.

Portugal Average Monthly Wage Formula was applied: €1,144.61 vs. €1,597.10 was the lost productivity cost for normal and abnormal cervical curves respectively. Though there was a difference, the 1% difference was not statistically significant. It does not discount other correlations between neck and back pain and lost forward head posture (FHP).



Item 6: WLQ Scaling and Scoring Process Version 1.0: May 2018. Review Copy

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Work Limitations Questionnaire© Version 1.0

Scaling and Scoring Version 1.0: May 2018

Written by:
Mapi Research Trust 27 rue de la Villette 69003 Lyon France

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Item 7: Absenteeism Questionnaire:

Link: (https://fisico.typeform.com/to/awwnzx)

Universidade Europeia
LAUREATE INTERNATIONAL UNIVERSITIES

Caro Participante,

O meu nome é Dr. Andrew P. Hatch e sou candidato de Doutoramento na Universidade Europeia.

Gostava de contar com a sua disponibilidade para responder a este questionário e dar a sua experiência sobre o processo de diagnóstico e tratamento às suas condições musculoesqueléticas (tais como dores lombares, dores cervicais, etc.). O questionário demora no máximo 2 minutos.

Os dados recolhidos serão de grande utilidade para analisar os benefícios e o impacto organizacional resultante dos cuidados de saúde providenciados aos colaboradores, no que refere às condições musculoesqueléticas tais como dores lombares e dores cervicais no local de trabalho.

Obrigado,

Dr. Andrew P. Hatch

Nota: Os dados recolhidos são anónimos e tratados confidencialmente (não haverá perguntas de identificação pessoal). Os dados não serão vendidos ou entregues a terceiros.

1. É paciente da clínica On-Site? (recebe tratamentos na clínica do seu local trabalho)
    a. Sim
    b. Não

2. No último ano, quantas vezes foi obrigado a ausentar do seu trabalho devido às condições musculoesqueléticas tais como dores lombares, dores cervicais, etc.?
    a. 0 dias
    b. 1-2 dias
    c. 3-5 dias
    d. 6-10 dias
    e. 11-15 dias
    f. mais de 16 dias

3. No último ano, quantas horas teve de ausentar do trabalho por cada consulta/tratamento (em média)?
    a. 0 a 1 horas por consulta
    b. 1 a 3 horas por consulta
    c. 3 a 5 horas por consulta
    d. mais de 6 horas por consulta

4. No último ano, quais os médicos/especialistas que teve de consultar fora do local de trabalho para diagnosticar e tratar a sua condição musculoesquelética (tais como dores lombares, dores cervicais, etc)?
    a. Médico de Família
    b. Cirurgião Ortopédico
    c. Neurocirurgião
    d. Fisiatra
    e. Fisioterapeuta
    f. Nenhum

5. No último ano, pense na sua mais recente condição musculoequelética (tais como dores lombares, dores cervicais, etc.). Quantos dias passaram entre os primeiros sintomas e o início do tratamento efetivo da condição?
    a. 1 a 6 dias
    b. 7 a 14 dias
    c. 15 a 21 dias
    d. mais de 22 dias

6. No último ano, quais os exames de diagnóstico teve de fazer para diagnosticar e tratar a sua condição musculoesquelética (tais como dores lombares, dores cervicais, etc.)?
    a. Raio-X
    b. TAC (Tomografia Axial Computorizada)
    c. MRI (Ressonância Magnética)
    d. EMG (Electromiograma)
    e. Nenhum

Item 8: Results: Absenteeism Questionnaire

1. É paciente da clínica On-Site? (recebe tratamentos na clínica do seu local trabalho)

274 de 274 pessoas responderam esta pergunta

- Sim 163 / 59%
- Não 111 / 41%

2. No último ano, quantas vezes foi obrigado a ausentar do seu trabalho devido às condições musculoesqueléticas tais como dores lombares, dores cervicais, etc.?

274 de 274 pessoas responderam esta pergunta

- 0 dias 126 / 46%
- 1-2 dias 85 / 31%
- 3-5 dias 33 / 12%
- 6-10 dias 13 / 5%
- mais de 16 dias 11 / 4%
- 11-15 dias 6 / 2%

3. No último ano, quantas horas teve de ausentar do trabalho por cada consulta/tratamento (em média)?

274 de 274 pessoas responderam esta pergunta

- 0 a 1 horas por consulta 160 / 58%
- 1 a 3 horas por consulta 106 / 39%
- 3 a 5 horas por consulta 8 / 3%
- mais de 6 horas por consulta 0 / 0%

4. No último ano, quais os médicos/especialistas que teve de consultar fora do local de trabalho para diagnosticar e tratar a sua condição musculoesquelética (tais como dores lombares, dores cervicais, etc.)?

274 de 274 pessoas responderam esta pergunta

- Nenhum 118 / 43%

- Médico de Família 112 / 41%
- Fisioterapeuta 82 / 30%
- Cirurgião Ortopédico 41 / 15%
- Fisiatra 37 / 14%
- Neurocirurgião 34 / 12%

5. No último ano, pense na sua mais recente condição musculoequelética (tais como dores lombares, dores cervicais, etc.). Quantos dias passaram entre os primeiros sintomas e o início do tratamento efetivo da condição?

274 de 274 pessoas responderam esta pergunta

- 1 a 6 dias 179 / 65%
- 15 a 21 dias 39 / 14%
- 7 a 14 dias 39 / 14%
- mais de 22 dias 17 / 6%

6. No último ano, quais os exames de diagnóstico teve de fazer para diagnosticar e tratar a sua condição musculoesquelética (tais como dores lombares, dores cervicais, etc.)?

274 de 274 pessoas responderam esta pergunta

- Nenhum 139 / 51%
- Raio-X 121 / 44%
- MRI (Ressonância Magnética) 45 / 16%
- TAC (Tomografia Axial Computorizada) 42 / 15%
- EMG (Electromiograma) 28 / 10%

Item 9: A Detailed Review of Known Studies (Section 4, Table 1).

The following 20 studies were evaluated and summarized for the purpose of finding previously used research methods and instruments for the evaluation of off-site MSD intervention studies, wellness programs, on-site clinic studies. Dozens more studies were evaluated but the studies below were chosen for their focus on economic outcomes and impacts caused by disability, absenteeism and productivity, rather than merely clinical outcomes, making them relevant to business management research and the topic of this thesis. The author was unable to find any papers which compared the econometric outcomes or a comparative analysis of On-Site vs. Off-Site clinics in the context of MSD interventions.

Review of 10 Off Site MSD Intervention Studies:

Study #1: *Preventing Chronic Disability from Low Back Pain; Renaissance Project* (Leech, 2004).

Setting: Republic of Ireland. The Department of Social and Family Affairs (DSFA) in the Republic Ireland, conducted a country case study titled "The Renaissance Project" between January and June 2003. The aim of the project was to prevent chronic disability from low back pain by using an early intervention strategy.

Method: The subjects of the study included 3,300 new claimants for Disability Benefit and Injury Benefit between the ages of 20 and 50 years old who suffered from GP-certified low back pain (LBP). The two groups consisted of the early intervention (EI) group and a control group. The participants or claimants were placed into one of three categories. 95% of the subjects were diagnosed with non-specific or simple back pain, 3-5% with nerve root pain and 1-2% of the cases with potentially serious spinal pathology. The simple back pain claimants were assessed for their work capability, potential for work restriction or possibility of changing job demands based on the severity of their symptoms. The assessments consisted of medical examination and questionnaires.

Outcomes: The following outcomes were reported of the initial 3,300 disability claimants.

- 1,700 (51%) returned to work within 4 weeks.

- 1,600 were selected for early referral (4-6 weeks) and asked to schedule a medical assessment.
- Of these 1,600, a total of 1,000 decided to return to work and were not medically assessed.
- The remaining 600 opted for medical assessment using a diagnostic triage approach.

Results: There was a marked decrease in the proportion of claimants progressing from simple back pain to chronic disability. This translated into a greater number of claimants returning to work with 64% capable of work in the study assessment group compared to only 20% of the claimants assessed in the previous year. The study also demonstrated that fewer claimants appealed their medical assessments for disability (44% versus 61%) than during the previous year. There was an overall reduction of claims that progressed to long duration by 40% compared with the previous year control group which translated to savings of over €560,000.

The study was deemed a success by the Irish government and has been extended beyond the original scope and has continued to produce positive results. It demonstrated that a targeted early intervention program for low back pain yielded the following results.

- Reduce progression to chronic disability.
- Improve the health of claimants.
- Reduce health care costs.
- Reduce absence from work.
- Improve productivity.
- Yield savings for long-term benefits schemes.

Study #2: *High Cost-Benefit of Early Team-Based Biomedical and Cognitive-Behaviour Intervention for Long-Term Pain-Related Sickness Absence.* (Ektor-Anderson et. al, 2008)

Setting: This study came from the Multidisciplinary Pain Clinic, Primary Care Region Skane, Malmö, Sweden and the National Research Centre for the Working Environment, Copenhagen, Denmark. The researchers from these institutions developed an early intervention program for MSDs to prevent long term absence from work.

Method: The program was conducted in one of the 54 primary healthcare physiotherapy clinics in the region and began in November 2000 and lasted for a period of 16 months. The eligible study

group only included working age people between the ages of 10 and 65 who were currently on sick leave and who had 3 months or less of pain-related sick leave in the previous working year. The eligibility data was derived from the National Social Insurance Board and from self-reports.

All participants were asked to complete a questionnaire (Orebro Musculoskeletal Pain Questionnaire, OMPQ-r) during their first visit to the clinic. From an original group of 2,550, only 575 reached this stage of the project and were randomly assigned to two groups. Both groups were selected based on similar socioeconomic indicators of which, 194 were assigned to the intervention group and 381 to the control group.

Intervention: The intervention consisted of several stages, a work disability assessment, a functional behaviour analysis tool, also known as CBT or cognitive behavioural therapy and the application of such tools as well as physical therapy.

Stage 1. The first stage was the *work disability assessment* where participants were evaluated by a physiotherapist and rated on a scale of 1-11 based on their probability of returning to work following a specific treatment.

Stage 2. *CBT or Cognitive Behavioural Therapy* which was a team-based functional behaviour analysis tool. This tool focussed on four factors or external sources of risk which included 1. Community. 2. Workplace. 3. Family. 4. Health care. Clinicians looked at these four life style factors to determine their impact on the severity of the MSDs and the likelihood of recovery and return to work.

An additional three factor tool was used to assess the participant's scores on the following factors; 1. Cognition. 2. Behaviour. 3. Physio-psychological scales.

Stage 3. *Clinical application tools* including interviews and physical examinations. The primary care teams determined the best course of action and most beneficial form of rehabilitation based on the participant's clinical findings and dependent on the nature of their conditions. Once determined as to the most beneficial course of action, whether it be CBT, physiotherapy or a combination, the sessions were then administered for a year.

Results: The intervention group demonstrated a 5 percent lower incidence of sickness absence over the one year study compared to the control group.

Compensated sickness absence days taken per person:

- Control group: 91.7 days per person.
- Intervention group: 76.9 days per person.

A reduction of 14.8 days per person per year which translated to a €236,357 reduction in social security expenditures during the year of the program. The social security savings alone paid for the direct costs associated with the intervention program which included staff salaries, rental space and materials which totaled €235,681 over the same year. The research team speculated that the intervention would likely have a far greater social and economic cost benefit if such factors such as productivity, social and other cost avoidance factors were included.

Study #3: Danish case study: *Coordinated and tailored work rehabilitation; a randomized controlled trial with economic evaluation undertaken with workers on sick leave due to musculoskeletal disorders* (Bültmann et. al. 2009).

Setting: This study in Denmark was based on the development of an innovative approach called CTWR or "coordinated and tailored work rehabilitation". The objective of the study was to compare the effects of two approaches to MSD interventions, CTWR with CCM or conventional case management on return-to-work (RTW) of workers on sick leave due to MSDs.

Methods: The study was a randomized controlled trial of workers on sick leave for 4-12 weeks due to MSDs to evaluate economic impact of the CTWR approach. CTWR consists of interdisciplinary teams performing disability screenings to develop collaborative RTW plans for the workers on sick leave.

Outcomes measured:

- Primary outcome measure was cumulative sickness absense hours during a 12 month period.
- Secondary; work status, pain intensity and functional disability were measured at 3 and 12 months follow up.
- Economic evaluation; intervention costs, productivity loss, healthcare utilization costs based on administrative data from national registries.

Results: For the time intervals 0-6 months, 6-12 months and the entire follow-up period.

- CTWR group had significantly lower sickness absence hours compared to the control group.

- CTWR resulted in a total cost savings compared to control group estimated as US $1,366 per person at 6 months follow-up and US $10,666 per person at 12 month follow-up.

Conclusion: associated with the CCM.

Study #4: *Effects of co-financed interdisciplinary teamwork on sick leave for people with musculoskeletal disorders*. (Hultberg, Lönnroth, Allebeck, & Hensing, 2006)

Setting: Stockholm Sweden. The study was designed to evaluate the impact of a co-financing model (Socsam) of collaborative rehabilitation between primary healthcare, sickness insurance and welfare office for MSD patients compared with conventional rehabilitation model that took place in eight parts of the country.

As background to the study, it should be noted that in most E.U. member countries, the delivery of health and welfare services involves several authorities including, health care, sickness insurance, social services and labour offices and there is often a lack of coordination between them therefor making it difficult for the end user, the patient, to utilize the services effectively (Saltman & Figueras, 1997). Salman (1997) states that patients in need of care are often shuffled between the various authorities with little to no organized plan for rehabilitation. The theory being that a co-financed and thus coordinated effort would result in a decrease in work absence by simplifying the process for the patient.

Method: A comparative prospective study was conducted by performing interviews of patients aged 16-64 with MSDs being treated in health centres with (n = 107) and without (n = 31) a co-financed model. The researchers also collected sickness allowance data over a total of 18 months. The co-financed centres had the opportunity to intensify the rehabilitation approach by including other professionals such as social workers, physiotherapists, occupational therapists and social insurance officers. The patients in both settings received similar physical therapy interventions for their MSD complaints. The four control health centres were outside the intervention project territory with no intentions of modifying their approach to care or collaboration.

All patients were interviewed at the time of inclusion into the program and after 6 and 12 months. Sick leave was defined by any period greater than 14 days, as the first two weeks were covered by the employer.

Results: At the beginning of the study when the participants were initially accepted for the program, 64 persons (60%) in the intervention group and 14 persons (45%) in the control group were initially sick listed. Among the initially sick listed persons, there was a higher proportion of the intervention group that was not sick listed after 12 months compared with the control group. As the study continued however, of the participants that were not initially sick listed, a higher percentage of the intervention group was sick listed after 12 months. At 12 months, the distribution of patients sick listed was nearly the same with 31% in the intervention group and 32% in the control group.

Conclusion: The researchers basically arrived at a null-hypothesis. Thy concluded, based on their methods and measurements that the co-financed model with structured collaboration among personnel does not reduce the number of sick leave days among patients with MSDs nor could they demonstrate that the model significantly increased the relative percentage of part time sick leave. The authors suggested a possible cause for the null results in the study was a lack of new or improved working procedures within the collaborative model.

Study #5: *Interventions for musculoskeletal disorders in computer-intense office work: a framework for evaluation.* (Cole & Wells, 2002).

Setting: This study took place in Ontario Canada within a large metropolitan newspaper.

Method: Evaluation of an employee population of 1200 office workers who spend most of their time sitting at computers. This study was the extension of an ongoing study of WMSDs in collaboration with the newspaper since 1995. The researchers evaluated the most common WMSDs referred to as repetitive strain injuries (RSIs) of the upper extremities. Their assessment of the workers was done using a cross-workforce survey (Polanyi et al., 1997) as well as a study of various risk factors associated with MSDs.

Results: Based on their study findings as well as best practices found in the literature, a series of recommendations were given to the newspaper and primary stakeholders. These recommendations

were then incorporated into agreements between union representatives and management of the newspaper (Polanyi & Cole, 2001) and formed the foundation of the case study. See table 1.

Their approach was to identify and report specific risk factor for RSI in the workplace as well as strategy recommendations for dealing with RSIs.

Conclusion: The broad goals of the changes are: improved musculoskeletal health and better organizational performance. The researchers outlined specific strategies for each area of activity in the organization including Policy, Human resources, Teamwork, Equipment and environment and information systems. They outlined the objectives and metrics for intermediate and longer-term outcomes for each of the strategies implemented.

The researchers concluded that the application of the evaluation framework was helpful in covering the complex range of outcomes from the very wide range of activities which occur in the workplace. The framework forced the researchers to focus on the many different types of qualitative and quantitative data that must be collected in the workplace environment.

Study #6: *A Health System Program To Reduce Work Disability Related to Musculoskeletal Disorders (Abásolo et. al., 2005).* Brief Description above.

Setting: Three health districts in Madrid, Spain.

Terms: TWD=temporary work disability. PWD=permanent work disability.

Method: A randomized, controlled intervention study. The conclusions and follow-up periods each lasted 12 months. The subjects of the study were taken from a pool of patients with MSD-related temporary work disability during 1998-1999. The control group were referred to standard primary care management and to specialized care if needed. The early intervention group were sent to a specific program administered by rheumatologists. The care was delivered during regular visits which included 3 main elements: education, protocol-based clinical management, and administrative duties.

The researchers measured two efficacy variables. 1) days of TWD and 2) number of patients with PWD.

Patients from the various districts in Madrid experiencing MSDs were seen by primary care physicians to be evaluated for their condition and provided a temporary work disability form. The

patients who were experiencing MSD pain not caused by cancer, nerve entrapment syndrome, work trauma or surgery but from acute or chronic low back, neck and or extremity pain were qualified for the study. They were randomly selected to participate in the intervention group and contacted as soon as possible after the initiation form was issued.

The intervention group were consulted by rheumatologists in each district and seen as often as needed until the episode of temporary work disability was resolved or recovery was deemed improbable. Intervention in the study group included regular visits, education on self-care, ergonomics, movement and management of the condition, clinical management using primarily pharmaceuticals and administrative duties performed by the doctors and staff such as filling out forms, writing prescriptions and reports for the Inspection Services.

The intervention group consisted of three levels of care. The time spent in the first level was between 2-6 weeks and included diagnoses, medication for pain and inflammation and education. At the second level, patients received maintenance of pharmacological therapy, physical therapy or rehabilitation, diagnostic imaging such as x-ray, magnetic resonance (MRI) or computerized tomography (CT) and electromyography (EMG). If patients did not demonstrate improvement after 4-6 weeks, they advanced to the third level for further diagnostics or surgical consult.

Treatment failures that were non-surgical cases were further evaluated for what the researchers referred to as “yellow flags” including psychosocial causes, mental illness, family problems or work conflicts. The patients stayed on TWD if full recovery was deemed unlikely.

13,077 patients participated in the study of which, 7,805 were in the control group and 5,272 in the intervention group resulting in 16,297 episodes of MSD-related TWD.

Measurements: Episodes of TWD due to MSD were defined by the start of the episode (the day the initiation form was issued to the patient) and the conclusion (the day the end form was issued) by the attending physicians. The efficacy measures between the two groups were, 1) the duration of all episodes of MSD-related TWD per patient. 2) the number of such episodes per patient and 3) the number of proposals for PWD.

Effectiveness was measured as the percentage of days saved that a patient was on TWD and a total number of days on TWD saved in the intervention group. Cost-efficacy was defined as the total

expenditure required to save one day of TWD. Cost-benefit was defined as money invested divided by money saved. Net-benefit was defined by money saved minus money invested.

Results/conclusions: The episodes of temporary work disability in the intervention group were shorter than in the control group (mean, 26 days compared with 41 days) with similar numbers of episodes per patient. In the intervention group, fewer patients received long-term disability compensation than in the control group. Direct and indirect costs were lower in the intervention group compared to the control group. The program's net benefit exceeded $5 million. Evaluation of the study's costs demonstrated that $6.00 had to be invested in the program to save 1 day of temporary work disability which translated to each dollar invested in the program generated a benefit of $11.00.

This was proven to be a cost-effective program when offered to the general population which reduced short and long-term work disability outcomes.

Study #7: *Constructing the program impact theory for an evidence-based work rehabilitation program for workers with low back pain (Durand et. al., 2003).*

Setting: Quebec, Canada.

Purpose: Several low back pain rehabilitation programs have been evaluated for outcomes over the years yet lack the exact mechanisms of action which these programs used to get people with low back pain to return to work. This lack of knowledge may lead program designers and professionals to implement less effective programs that don't achieve the desired outcomes. The purpose of this paper was to discuss the results of an exploratory study using impact theory for a rehabilitation program known as PREVICAP (PREVention of work handICAP). PREVICAP is a work rehabilitation program framed into a work occupational disability paradigm rather than a typical low back pain intervention paradigm that was taken from Serbrooke's (Loisel et.al., 2001) back pain management model which was assessed through population based randomized control trials (Loisel et. al.,1997) for the treatment of low back pain and return to work outcomes.

Methods: To build the program impact theory for the PREVICAP program, the researchers followed a systematic approach proposed by Rossi (1998) which used different tactics to collect data: 1) analyses of unpublished documents; 2) analyses of scientific literature; 3) interviews with a variety of stakeholders; 4) group discussions; 5) observations. This strategy allowed for the

development of 6) the final version of the program impact theory by writing and revising drafts based on findings and validation of those findings. See Figure 1.

The evaluation of program impact theory allows researchers to answer: 1) "did the program achieve the expected outcomes?" and 2) "how did the program achieve them?"(Petrosino, 2000) These two questions are the basic premise of this paper.

Results: The researchers elaborated on the PREVICAP program's impact theory model by using an ecological approach to work rehabilitation. The ecological approach is defined by three dimensions: the worker, the work environment and the interaction between the worker and their work environment. With this strategy, two program action mechanisms were well-defined which allowed for a clear explanation of how the rehabilitation program was intended to achieve its expected outcomes.

Conclusion: The use of program impact theory evaluation is highly useful for researchers, program designers and practitioners to develop and reproduce the program in other settings with the assurance that their decisions are evidence based, allowing them to make relevant recommendations and changes to the program from an informed position. Such an approach should qualify rehabilitation services for funding based on high quality of care and positive outcomes expectations based on evaluation of the evidence.

Study #8: *Early Workplace Interventions for Employees With Musculoskeletal-Related Absenteeism: A prospective Controlled Intervention Study* (Arnetz et al., 2003).

Setting: Sweden.

Methods: This was a prospective controlled trial that compared traditional case management for MSDs with a more proactive approach using case managers in addition to workplace ergonomics strategies' effect on sickness absenteeism. Patients were first diagnosed by a physician for the existence of MSDs and randomly selected to be part of the intervention group or sent for traditional case management. At the beginning of the study, each participant completed a comprehensive questionnaire which was repeated at six months. The administrative data was collected at six months and at twelve months.

Findings: Over the twelve-month period;

- *Number of sick days per person*: Intervention group: 144.9 (SEM 11.8)
  Reference group: 197.9(SEM 14.0) (P<0.01)

- *Complete rehabilitation investigation*: Intervention group: 84%
  Reference group: 27%

- *Time, in days, required for rehabilitation investigation*: >50% reduction
  Intervention group: 59.4(5.2)
  Reference group: 126.8(19.2), (P<.01)

- *Return to work odds ratio*: Intervention group vs. reference group: 2.5
  (95% confidence interval 1.2-5.1)

- *Direct cost savings*: Intervention group: USD 1,195 per case.
- *Benefit-to-cost ratio*: 6.8

Conclusion: The findings of the study suggest that a higher focus on early return to work as well as improving work-ability and functional capacity of the employee is an effective strategy for the insurance case management of MSDs. Active participation of the insurance case manager and ergonomist in workplace adaptation meetings might prove to be valuable.

Study #9: *Effects of ergonomic intervention on work-related upper extremity musculoskeletal disorders among computer workers: a randomized controlled trial* (Esmaeilzadeh et al., 2014).

Setting: Istanbul University Istanbul Faculty of Medicine.

Methods: Questionnaires were filled out by four hundred computer workers suffering from work-related upper extremity disorders (WUEMSDs). Those workers who worked at least three hours per day on a computer and suffered from one or more of the following musculoskeletal symptoms; neck, upper back, shoulder, elbow or wrist pain, tingling, numbness, burning that started during their current employment. The subjects participated in a prospective, randomized controlled six-month ergonomics intervention. Data was collected via self-reported questionnaires. Questionnaires concerning body posture when working and work station evaluation were assessed using the *Ergonomic Questionnaire*. The intensity of the WUEMSD was measured using the

Visual Analogue Scale. Functional limitations were measured using the *Upper Extremity Function Scale*. Quality of life/ health-related issues were measured using the *Short Form-36.* When assessments were completed, the intervention group participated in a three part ergonomic intervention program that included, interactive education sessions about workstation posture, exercises and positioning, workstation adjustments and training brochures. Participants were reevaluated after six months.

Results: In the intervention group, body posture, workstation layout improved over the six months. There was also a significant decrease in pain intensity, duration and frequency among the intervention group compared to the control group. Functional and physical capacity improved significantly as did mental and health-related quality of life compared to the control group. This study did not demonstrate any improvement in work related absenteeism.

Conclusion: The use of an ergonomic intervention strategies was shown to be effective at reducing the symptoms associated with WUEMSDs by reducing the risk factors of poor posture and poor ergonomics at the workstations that may also lead to prevention of such conditions. The null impact on work absence was attributed to the small sample size and the short period of the study.

Study #10: "A review of best work-absence management and return-to-work practices for workers with musculoskeletal or common mental disorders" (Durand et. al., 2014)

Setting: Canadian research team.

Methods: A literature review of English and French research between 2000 and 2011 was done on the best practices for managing work absences related to MSDs such as low back pain and common mental disorders such as stress and anxiety. The researchers used bibliographic databases and work-disability research institute websites. They built a chronological framework based on the best absence management and return to work practices extracted from the documents which served as the foundation for recommendations.

Results: A total of 17 documents were analyzed by the researchers to identify common work-absence management and return to work practices. They also identified the importance a of worker support approach and the roles and responsibilities of stake holders in the support process. From this collection of processes, they formulated a six-step process:

7. *Time off and recovery period.*
8. *Initial contact with worker.*
9. *Evaluation of the worker and his job tasks.*
10. *Development of a return-to-work-plan with accommodations.*
11. *Work resumption.*
12. *Follow-up of the return-to-work process.*

Conclusions: The researchers believe that their review of best practices assisted them in constructing a useful, logical and comprehensive work-absence management and return-to-work process for organizational management of these cases. They concluded that such a process would be more effective if used within a broader organizational perspective on health promotion and employee retention.

In general, the above studies demonstrate a consistent pattern of decreased absenteeism and early return to work for patients/employees who have MSD early intervention strategies made available to them. The literature demonstrates that a focus on MSD intervention, prevention and education strategies along with employee support strategies using a team approach ultimately lead to widespread productivity increases among all employee types and groups from white collar to manufacturing.

Review of 10 On-Site MSD Intervention Studies:
This section will discuss some individual case studies and the respective results each approach had on their client's healthcare cost outcomes.

In doing a search for articles in scientific journals with studies on the impact of On-Site primary care clinics, very few recent (2010-2015) scientific journal articles were found. What did arise from the search process were several industry articles produced by consulting firms primarily in the United States as well as articles in reputable mainstream journals and periodicals but are not included in this section. To present information in a scientific manner, I have chosen only published studies for this discussion. There is an explanation as to why there appears to be a shortage of published scientific studies. According to Pelletier (2009) in his analysis of workplace health care studies, he notes that there has been a marked decline in both the quantity and quality of studies since 2004. He attributes this phenomenon to an increased demand by corporations looking primarily for clinical and cost outcomes to justify their investments in chronic disease

management and health promotion. Of the 16 studies, he evaluated, only one study was of true experimental design while the others were financial outcomes case studies of lower quality. This is an industry trend that he believes may potentially have a negative impact on the field of corporate health and disease management. A report by the WHO European Working Group on Health Promotion Evaluation (Health Promotion Evaluation: Recommendations to Policymakers, WHO, 1998) may explain a possible reason for this trend: *"The use of randomized control trials to evaluate health promotion initiatives is, in most cases, inappropriate, misleading and unnecessarily expensive."* (Pelletier, 2009; Bauer et. al., 1985).

The following studies provide information about On-Site primary care facilities. The focus of such facilities, in the United States, is to reduce total health care spending for the self-insured employers by providing easy access to clinicians thus managing chronic diseases such as diabetes, heart disease and blood pressure more effectively. The stark difference to the previous studies presented in this chapter is that the primary care clinics for the most part, do not address MSDs in the workplace beyond the use of anti-inflammatory medications and referral to specialists. It appears too that the U.S. employers are concerned primarily with reducing direct medical costs thus little value is placed on reducing absenteeism or returning employees to work in a timely manner as is the primary aim of the E.U. nations.

When it comes to workplace health promotion program design and execution or On-Site clinic implementation, there is a great deal of variation (Pelletier, 2009). According to Pelletier's study (2009), a very important question arises as to what types of interventions have the highest success rate in terms of implementation and/or outcomes. His evaluation did not provide a general answer to that question but revealed it was useful to take "best practices" into consideration.

Under the context of health care cost containment strategies, a study by Towers Watson (Burgel & Childre, 2012) identified the top 12 tactics that successful companies implemented in 2011 to manage health care costs, 6 of which could be managed by occupational health nurses:

"• Rewards for enrollment in healthy lifestyle activities.

• Rewards for completing requirements of a healthy lifestyle activity.

• Use of health risk appraisals and biometric screenings for employees to be eligible for other financial incentives for healthy activities.

- *Providing employees with information on provider and/or hospital quality.*
- *Rewarding employees based on smoker or tobacco use status.*
- *Investing in enhancements to case management for serious conditions."*

(Towers Watson/National Business Group on Health, 2011).

The dissimilarity between U.S. and E.U. in relation to importance of priorities reveals a missing link in the research and an opportunity for both regions to leverage the others' knowledge and experience. The E.U. focuses on absenteeism reduction and return to work objectives through MSD interventions while the U.S. focuses on health care cost reductions through primary care chronic disease management strategies using On-Site primary care clinicians. The E.U. has clearly revealed that MSD is a primary cause of missed work and a financial drain on the NHS. Few U.S. employers have yet to acknowledge the full impact MSDs have on their organizations even though studies show MSD being a primary cost driver, yet few On-Site clinic providers offer MSD interventions. Combining evidenced based MSD intervention to the On-Site primary care model may prove to be an effective cost management strategy for employers in both regions.

Study #11: *"Primary Care as a Platform For Full Continuum Health Care Risk Management"* (Klepper, 2013).

Setting: 4 manufacturing facilities in the United States. Employers range from 440 to 3000 employees. Each location has had an active On-Site primary care facility between 18 and 36 months.

Method: Evaluation of the financial impact of a single primary care provider in four different employee settings. The analyses demonstrated the cost per employee per month of medical claims, surgical claims and medication claims prior to implementation of the clinic then adding the cost of the clinic and drug costs post implementation. The evaluation used a 12-month rolling average PEPM costs.

The data presented did not include episodic claims of $50,000 or more for a single patient in one year. Such claims are known as "shock losses" or catastrophic claims such as heart attack, severe illnesses or accidents requiring multiple surgeries or expensive emergency interventions. They are

difficult to prevent or impact in the first 3 years with the clinic since chronic problems have been brewing for years and accidents are unpredictable.

The cost data were calculated using the Milliman Medical Index (Mayne et al., 2013) for 2012-2012 based on a family of 4, including contributions from the employer, employee premiums and employee out of pocket expenses.

Study 1: Manufacturer-Union. 1,239 employees. 37 months of postimplementation data.

Study 2: Assembly Plant. 2,956 employees. 21 months of postimplementation data.

Study 3: Manufacturer. 658 employees. 21 months of postimplementation data.

Study 4: Local government setting. 440 employees. 19 months of post implementation claims data.

Outcomes: Studies 1,2 and 4 all demonstrated the same cost curve, with costs rising for 6 to 14 months' post clinic implementation followed by a steep drop. Case 3 the costs dropped almost immediately but there was no explanation as to why. The author speculated that these initial cost increase phenomena were due to "pent-up" demand associated with each group having insurance copays. Due to the high cost of copays prior to clinic implementation, a significant number of employees from each group avoided seeking care for fear of that expense. Once medical care was made available for "free" to employees, large numbers of employees were motivated to seek care for their unspoken health issues. The clinic vendor is faced with a situation that has been building up for years as employees avoided medical care. As the clinicians uncovered the needs and diagnoses of each employee, there was an initial increase in medications, labs, specialty consults and medical procedures. After a period of time, different in each case, the clinicians worked to control the situation and there was a sudden drop in health expenditures.

Conclusions: The same medical management model was used in all four case studies which resulted in a consistent lowering of cost curves across cases. The author also speculated that there was a decline in shock losses after the fourth year of implementation due to the aggressive life style and chronic disease management efforts of the primary care teams. In conclusion, managing risks using a primary care model is effective but not enough according to the author and risks outside of primary care should also be managed.

Study # 12: *Mercer 2015 Worksite Clinic Survey: Employers continue to launch worksite clinics despite ACA uncertainties (Mercer, 2015).*

Setting: U.S.A.

Methods: Questionnaire Survey of employers with 5,000 or more employees. The organizations provided On-Site or near-site primary care clinics to employees and or their dependents. 134 respondents who also participated in the Mercer "National Survey of Employer Sponsored Health Plans 2014, were given a detailed follow up questionnaire about their clinic operations.

Conclusion: Measuring return on investment (ROI) remains a challenge for these organizations with only 41% providing ROI data. 23% of those were in the 1.00 to 1.99 range while 13% reported a 2.00 ROI or higher and only 5% reported an ROI less than 1.00. The survey found that the best measure of employee success was utilization by employees and dependents with 45% or employees using the clinics in 2014. Interesting to note that 48% of the employers offering primary care clinics didn't require any copayment while 25% offered services with a copay lower than the local market services available on the company health plan. 61% of the employers with employees on hourly wages did not require them to clock out if they were going to a medical consult in the On-Site clinic. 49% of respondents said that employees and dependents could use the On-Site clinic as their primary care provider.

Study # 13: *Integrating primary care with occupational health services: a success story* (Griffith & Strasser, 2010).

Setting: Intel Corporation, Phoenix, AZ, USA.

Methods: A pilot study of an On-Site primary care clinic among a self-insured manufacturing company's employee population of 10,000. Two clinics were established to service two campuses. The services included occupational health services, physical therapy, primary care, urgent care, uncomplicated illness treatment and vaccinations. The clinics were staffed with primary care physicians, nurse practitioners, physical therapists and other health care professionals. The clinics were established to manage risks previously identified via risk appraisals among the employee population. The hypotheses of the study was that providing On-Site healthcare would reduce total healthcare expenditure for the employer and save money for employees.

A thorough ROI projection evaluation study was performed to determine the costs of establishing a clinic, including physical space needs, staffing needs and the scope of practice that would be provided. The evaluation of employee health claims data assisted in the predictive cost of service if provided On-Site.

Metrics for the evaluation:

- Number of primary care worker encounters.
- Number of all visit encounters.
- ROI:
- Customer satisfaction ratings, including convenience of having On-Site care available.

Results: The pilot clinics were operating with a positive cash flow within the first year. The key outcome metrics exceeded projections as well as benchmarks for similar clinics.

Conclusion: The results of this study clearly point to the cost benefits of the On-Site model. Interesting to note that the use of physical therapy services for MSDs such as low back issues was a primary driver of the high performance compared to the benchmark clinics.

Study # 14: *A benefit-cost analysis of a worksite nurse practitioner program: first impressions* (Chenoweth et. al., 2005).

Setting: North Carolina, USA. Industrial metal/plastics manufacturing firm. The objective of the study was to assess the financial impact on health care costs by using an On-Site nurse practitioner for the care of 4,284 employees and their dependents.

Methods: The researchers analyzed the health care costs by two methods. First method: They compared annualized actual values for the first 6 months of the start up year (2004) with those projected for 2004 based on an evaluation of claims paid in 2002 and 2003. Both aggregate and per-individual health care claims were used as the basis of comparison. The "benefit" of the nurse practitioner program was defined as the difference in health care costs between projected and real cost values for 2004. Second method: Health care costs were calculated using 2003 paid insurance claims for major diagnostic categories. These health care claims were compared with claims that would have been incurred for the same major diagnostic categories addressed by the nurse practitioner had they been addressed Off-Site in 2004. The benefit-to-cost ratio used the cost of

the nurse practitioner ($82,717) as the denominator and used the savings in health care claims estimated by the two previously mentioned methods.

Cost Benefit Ratio used: Net benefit being the reduction in medical costs, disease or disability.

Net Benefit = **[**ΣL$ + ΣGP + ΣPI**] –** C

ΣL$: direct benefit is the reduction in medical care costs, disease and disability.

ΣGP: increased productivity leading to increased output and income.

ΣPI: gain in working income due to reduced illness, injury and impact on absenteeism (lost income).

C: cost of intervention in this case, the Nurse Practitioner.

Results: The savings in health care costs using method #1 were $1,313,756 per year with a benefit-to-cost ration of 15 to 1. Method #2 using major disease category analysis yielded a ratio of 2.4 to 1. The authors partly attributed the difference in ratios to the effects of a concurrent wellness program and 24/7 Nurse Health Line. They noted that the Nurse Health Line was established 10 months prior to the nurse practitioner program and contributed to workers and dependents avoiding costly emergency room visits.

Benefit = Cost Savings

	Benefit $	Cost $	R.O.I.	Median ROI
Methodology #1	$ 1,313,756	$82,716	15.88 to 1	
	---	---	---	9.13 to 1
Methodology #2	$ 197,550	$82,716	2.38 to 1	

Conclusions: The evaluation of the first six months of the nurse practitioner initiative yielded significant reductions in health care cost justifying further evaluation and follow up over a longer period. The same research team did a three year follow up study discussed below.

Study # 14a: *Nurse practitioner services: Three-year impact on health care costs* (Chenoweth et. al., 2008).

Based on the favorable results of study #14 above, the researchers did a three year follow up study to analyze the impact of providing On-Site Nurse Practitioner services had on health care costs.

Methods: The same methods and measurements were used to evaluate the financial impact of the nurse practitioner program. Method 1 compared actual health care costs for 2005 to 2007 verses projected health care costs, the latter based on medical payments in 2002 to 2004 prior to the nurse practitioner intervention. Method 2 as in the first study, compared the health care costs of major diagnostic categories which accounted for 88.5% of all conditions the nurse practitioner treated between July 2005 to December 2006.

Results: The cost of the nurse practitioner program during the study was $124,750. Using method 1, the savings in health care costs were $1,089,466 per year resulting in a benefit-to-cost ratio of 8.7 to 1. Using method 2, the savings in health care costs yielded a 2.0 to 1 ratio. As in the previous study, the authors comment that some of the health care cost savings using method 1 may have partially resulted from the use of the 24/7 Nurse Help Line.

Conclusion: As in the previous study, the 3-year analysis confirms the positive benefit-to-cost findings that resulted with the implementation of the On-Site nurse practitioner program. Substantial savings have been achieved since the program started but one should keep in mind the parallel wellness programs and Nurse Help Line which also contributed to employee awareness and the avoidance of expensive Off-Site interventions.

Study # 15: *Monitoring worksite clinic performance using a cost-benefit tool* (Tao et al., 2009)

Setting: United States, Pepsi Bottling Group, 26 actively running On-Site clinics serving 33,000 employees and their families in 18 states. The employee populations in each location ranged between 200 and 700 employees. The purpose of the study was to evaluate the value of an ROI methodology to continuously assess the performance of the On-Site clinics. The clinics were evaluated from the day they first opened throughout the period of the study.

Methods: An Integrated Claims Management System (ICMS) was used to record all information generated by clinical activities. The ICMS is a web-based electronic health records system that

allows for transfer of patient information to multiple parties including physicians, laboratories and providers. All the data were collected from the ICMS for all the clinics in the study.

The ROI was calculated using a per-encounter index savings (PEIS) outcome. The PEIS is a quantitative value that estimates cost savings associated to a single clinic encounter classified in the following ways: 1) occupational, 2) non-occupational, and 3) testing. The approximate cost of each type of visit is based on local market cost norms for each region and used as the comparison to the cost of On-Site clinic operations.

The ROI average for the clinics was dependent on the total number of clinic visits. The total number of clinic visits was dependent on the penetration/utilization rate and the size of the employee population in each location. Clinics opened for operations at different times during different years thus the ROI was calculated using the multivariate linear regression model.

Formula: ($P < 0.001$; $R^2 = 0.0572$):

ROI = 0.0014187 X number of employees + 3.6896 X penetration/ utilization rate per period.

Results: The average ROI of the 26 On-Site clinics in this study was 0.4 at start up. This increased to 1.2 at roughly month 4 and up to 1.6 at the end of month 12. The study demonstrated that the cost of operating the On-Site clinic becomes quite equal to the cost of local medical services (ROI = 1) after 3 months of operation then flattens out by the end of the first year. The rate at which an ROI is achieved is directly related to the population size of each location and the penetration/utilization of the clinic.

ROI Estimations Given Different Employee Numbers and PBG Period Penetration Rates: employee populations of 100 required a penetration rate of 25% to show an ROI, a location with 200 employees 20%, and 300 employees just over 15%.

Conclusion: The use of the ROI calculation method for this study yielded similar cost savings results to other studies focused on the delivery of primary care using an On-Site clinic and nurse practitioners to provide medical care to employees. As the clinics matured over time, direct medical cost savings did not show variations or great increases other than seasonal usage such as for flu shots. This tool allows managers to keep an eye on clinic performance from beginning to maturity. The tool did allow for additional cost savings metrics such as return to work time, replacement labor costs avoided, and third-party administration costs avoided. The authors

admitted that the use of this specific method design does not allow for savings calculations associated with avoiding or reducing workers' compensation costs which may demonstrate even greater savings. Such cases are typically not treated in the On-Site clinic due to laws surrounding them. Overall, the tool is an effective monitoring methodology of clinic performance.

Study # 16: *A Review and Analysis of the Clinical and Cost-Effectiveness Studies of Comprehensive Health Promotion and Disease Management Programs at the Worksite: Update VII 2004-2008* (Pelletier, 2009).

Setting: This paper is the seventh periodic review and analysis of the clinical cost-effectiveness research conducted in worksite/corporate settings between 2004 and 2008.

Methods: Pelletier (2009) performed a literature review of US-based cited research studies from peer reviewed journals using the following sources: MEDLINE, ADI, EDGAR, CARL, Inform, Lexis-Nexis. He also consulted fellow researchers with expertise in On-Site clinic cost effectiveness studies.

> **Inclusion Criteria**: *"Those programs that provide an ongoing, integrated, program of health promotion and disease prevention that integrates the particular components (ie, smoking cessation, stress management, lipid reduction, etc.) into a coherent, ongoing program that is consistent with corporate objectives and includes program evaluation."*
>
> **Exclusion Criteria:** *"Single-risk factor studies…such as smoking cessation and hypertension screening… Studies or demonstration projects of non-experimental design…anecdotal, purely descriptive, and qualitative studies…"*

Results: There were 16 new studies between 2004 to 2008 identified in the search that met the Inclusion/Exclusion criteria of studies that examined clinical and or cost outcomes. The studies were critiqued, and their findings put into a table based on 13 variables. Fewer clinical trials were found compared to pre-2004 studies as well as fewer, control trials (RCT) of On-Site initiatives.

Only one study out of more than 153 studies in total, including the 16 in this review met the rigorous requirements of an RCT.

Conclusions: There is a trend toward studies of focused pre-experimental, pilot projects in disease management conducted by companies. These companies are looking to evaluate disease

interventions that are of specific interest to the employer. Large employers are looking for pre- and post-demonstrations of clinical and cost outcomes. This trend is thought to be caused by the employers need to find effective cost savings strategies which has led to an increase of said pilot studies, quasi-experimental methodologies and economic modeling that have led to new innovations. Despite the lack of RCTs and the limitations of current methods used in recent 153 studies cited during 2004 to 2008, including the 16 studies evaluated in this paper, research points to positive clinical and cost outcomes.

The studies cited in this paper and in previous reviews are useful sources of information that offer guidance for health insurance providers, self-insured employers, brokers, consulting firms, managed care organizations and governments when designing, implementing and evaluating clinical/cost outcomes of programs.

Study # 17: *Promising Practices in Promotion of Healthy Weight at Small and Medium-Sized US Worksites* (Hersey et. al., 2008).

Setting: United States. 9 small to medium-sized worksites in the manufacturing, construction, health care, higher education and government organizations.

Methods: An initial SWAT evaluation method was used to select candidates for the study and evaluated by expert panel members from the CDC for their meeting qualification criteria as "exemplary" worksite health promotion programs. The participating companies had employee populations ranging from 100 to 3,000. Mangers, including the CEO, HR directors, program directors and staff as well as vendors they used, that were selected and accepted to participate in the study underwent targeted interviews to gather information. Data points included, worksite characteristics, size of the workforce, types of jobs performed as well as socioeconomic characteristics of employees.

The researches evaluated the weight loss programs of each organization to learn the individual strategies used that lead to their individual success. A separate panel of experts evaluated the site visit reports to identify best worksite health promoting practices that were considered promising, feasible to implement in multiple settings, innovative, sustainable and relevant to public health objectives of maintaining healthy body weight.

Results: There were many innovative approaches to employee health and strategies for obtaining and encouraging healthy body weight that were discovered with this study:

- Peer coaching.
- Wellness screenings.
- Motivational interviewing.
- Follow up interviews.
- Free access to fitness facilities.
- Incentives such as days off or paid leave for participation in wellness programs.
- Introduction of incentives.

The study found that most programs built their business case by collecting aggregate data such as:

- Decreases in blood pressure.
- Decreases in blood serum cholesterol levels.
- Body weight in longitudinal samples of program participants were performed by 5 out of the 9 participants but with a variance in metrics used.

Conclusion: Promising practices of worksite wellness programs were identified that were associated with favorable health outcomes.

This study did not include the costs or benefits associated with running programs.

Study # 18: *Health care use associated with work related musculoskeletal disorders among hospital workers* (Koehoorn, 2006).

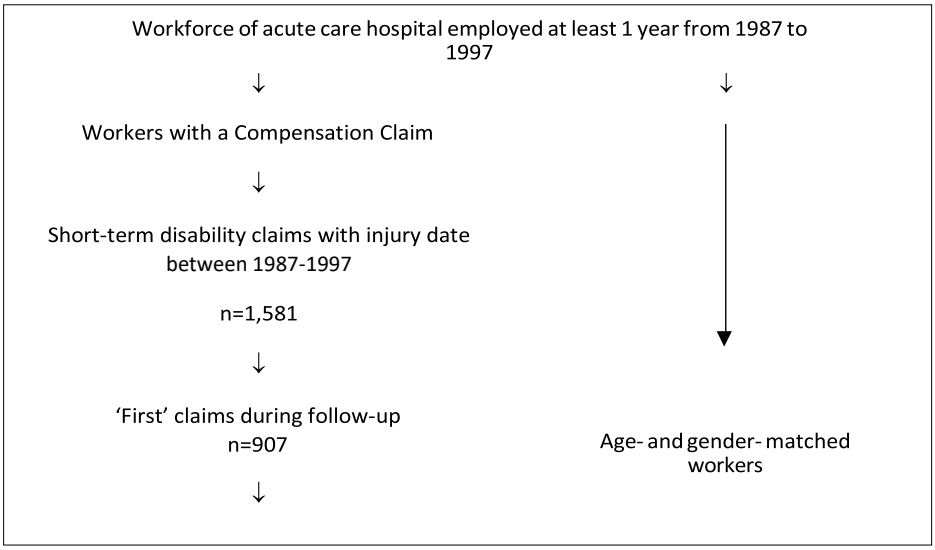
Setting: British Columbia, Canada. A group of hospital workers.

The purpose of this study was to investigate if employees with work related musculoskeletal disorders (WMSD) increased their usage of health care visits beyond their workers' compensation benefits to a greater degree than those workers without WMSDs.

Methods: This was a retrospective ten-year follow-up study (1987-1997) using secondary analyses of data to investigate patterns in health care use associated with WMSDs by comparing existing employee health care billing records and workers' compensation records of those

employees without WMSD claims. Predictors of health care contacts were estimated using linear regression.

Study Sample: Workers with workers' compensation claims (*n* = 549) vs. workers without (*n* = 549).



94% of all the WMSD cases were defined as sprains and strains with 53% involving the back, 7% involved the neck, 17% the upper-limb and 12% the lower limbs.

The majority of the WMSD claims group were nurses (40.8%) with a median age of 39.9 years.

Results: Employees with WMSD injuries were shown to have much higher rates of medical visits and associated health claims than employees without WMSD claims primarily in the first 12 months following the date of injury. The estimated increase in health care use for employees with WMSDs was 69%(95%CI,1.50,1.91).

Conclusion: The increase in health care visits is a pattern among those with WMSDs that suggest ongoing symptoms which require medical consults which occur prior to workers' compensation or disability leave and continue after medical leave has ended and return-to-work has begun.

Study # 19: *Impact of a health promotion program on employee health risks and work productivity* (Mills et. al., 2007).

The purpose of the study is as the title suggests.

Setting: Multinational corporation in the U.K.

Methods: The study was a quasi-experimental 12-month pre-post implementation control study. Employees were asked to complete questionnaires before and after the health promotion program was implemented. Of the 618 employees, 266 (43%) filled in the questionnaires. The control population group consisted of 2,500 non-participants of which 1242 (49.7%) also completed questionnaires 12 months apart.

The health promotion program consisted of several components: health risk appraisal questionnaire, a web-based portal with health tips, wellness literature/pamphlets as well as workshops and seminars targeted toward identified wellbeing issues.

Measures included:

- Cumulative count of health risk factors and the WHO health and work performance questionnaire measures.
- Workplace absenteeism.
- Work performance.

Results: Improvements in all three measured outcomes were greater among the intervention population compared to the control group.

- Reduction in health risk factors 0.45.
- Reduction in absenteeism-days missed from work, 0.36.
- Increase in work performance, 0.70

A positive ROI was reported for the intervention.

Conclusion: The results of the study suggest that a workplace health promotion program can yield positive changes in health risks and improved productivity if well implemented.

Study # 20: *Self-paced exercise program for office workers: Impact on productivity and health outcomes* (Low et. al., 2007).

Setting: Washington DC, United States. Subjects were recruited from a large federal office complex and participated on a strictly volunteer basis.

Methods: A 3-month quasi-experimental prospective study (pre-test, post- test) of a worksite self-paced exercise program. A single group of 32 participants completed the study. Walking was the primary form of exercise. The program was divided into three levels based on body weight, percentage of body fat and blood pressure goals:

- Level I: 2-pound weight loss, 1% decrease in body fat, 1-point decrease in systolic or diastolic blood pressure.
- Level II: 3-pound weight loss, 2% decrease in body fat, 3-point decrease in systolic or diastolic blood pressure.
- Level III: 5-pound weight loss, 3% decrease in body fat, 5-point decrease in systolic and diastolic blood pressure.

Productivity was measured using the Endicott Work Productivity Scale (EWPS) (Endicott, 1997), which is a 25 question self-report that measures behaviors, feelings and attitudes related to absenteeism, work quality, personal factors and work capacity. It is a tool often used by pharmaceutical companies but was effective for this study. Simple linear regression was used to compare the EWPS scores during the control period with those during the experimental period.

Results: Some of the results include; 22(66%) of the 32 participants lost a total of 290.5 pounds, ten lost 4 pounds or less. Four lowered either their systolic or diastolic blood pressure by 10 points or more. The maximum weight loss was 36.5 pounds, three lost 17 pounds and two lost over 20 pounds.

There were no significant correlations found between number of steps walked and productivity. Participants reported work stress, not enough time and an impersonal work environment may be the reason.

Conclusion: This study had many challenges with the small sample size and no actual control group to compare findings with. Though there was no correlation found with walking and productivity, the findings were positive for weight loss and lowering blood pressure which are two important risk factors for heart disease.