**Ergonomics 101**

A UNC-DPT Program Initiative to Decrease Musculoskeletal Injury Rates in Local Chapel Hill Businesses

**Statement of Need**

Back or neck pain will be experienced by 70% of the adult population in the US at some point in their lives.1 This is the cause for over 15 million outpatient physician visits for back pain alone.1 This is an enormous amount of people experiencing similar symptoms for a diagnosis that can be prevented in many cases. Low back and neck pain do not only involve physical symptoms, as they can also affect the psychological and mental health of the individual, which can affect their ability to work during the day. Those with low back and neck pain have been shown to be significantly more likely than those without to have frequent depressive or anxiety symptoms and insomnia.1 These individuals are also more likely to smoke, drink heavily, and be overweight than those without low back or neck pain.1

There has been strong evidence for an association between static and specific postures and neck musculoskeletal disorders.2 Physical workplace factors such as incorrect computer workstation set-up, prolonged worked in fixed positions, seated and static work and overuse have all been recognized as risk factors for musculoskeletal complaints.3 In a study of 175 data processors, 14% were absent in the last year secondary to musculoskeletal pain. Of all of the date processors in the study, 81% attributed pain and discomfort to work, listing poor seating, constant keying, sitting in the same position for hours, and computer set-up as potential causes.3 As these are all risk factors for those working in a setting with a computer set up on their desk, portable computers are becoming more standard in office settings; however, portable computers are still relatively new and it is uncertain if they are a better alternative in reducing musculoskeletal issues.

A study on regular users of portable computers in their work questioned 300 workers on work conditions, time using the computer, workplace setup, and prevalence of musculoskeletal problems.4 They found low back and neck pain as common complaints in users of portable computers, and were often associated with prolonged awkward body postures and ineffective workstation environments.4 They found many of the participants did not have proper workstations set up for portable computers, as many simply place the computer on a desk without a separate keyboard and did not have many adjustable parts to their chairs to account for the different setup of portable computers.4

In the growing Chapel Hill, North Carolina community, many businesses require their employees to perform repetitive tasks and long hours in front of their computers, whether they are desktops or portable. A result of these musculoskeletal issues, in particular neck and back pain, can turn into decreased productivity, increased burden on employers and employees, create an overall unsatisfactory working environment, and most importantly create chronic healthcare problems. Back and neck problems are the leading cause of job-related disability in the US and cost Americans more than $50 billion each year.1

Many musculoskeletal issues can be addressed by increasing one’s daily physical activity, strengthening postural and core musculature, or taking frequent rest breaks from sitting in one position while performing repetitive tasks. However, although these are excellent ideas, they are not always easy factors to implement into the lives of all desk workers. There is something that can be done that is cost-effective and within the office setting while people are working to create a more productive and pain-free environment: ergonomics. Ergonomics is an applied science concerned with designing and arranging items that people use so that the people and things interact in the most efficient and safe way.5

The focus of this program is to develop an ergonomic educational intervention program that targets the workforce in Chapel Hill. Addressing ergonomics in the workplace can benefit employees by decreasing their future risk of health care issues. In doing so, this can in turn lower the costs for employers and/or employees by lowering their insurance rates. It has been documented that ergonomic initiatives involving workstation redesign had 15% of an increase in productivity.6 There was also a review performed on the benefits of ergonomic programs, which reported largely positive results and payback periods being less than one-year typically.7 These benefits will also increase business productivity as a result of a more comfortable, stress free, and efficient working environment. We can provide these businesses with the education and resources to understand where and why there is a need to modify their workplace.

**Background**

 There has been strong evidence for an association between static and specific postures and neck musculoskeletal disorders.2 Back and neck problems are the leading cause of job-related disability in the US and cost Americans more than $50 billion each year.1Musculoskeletal disorders are commonly reported among office workers worldwide and they can have detrimental effects on workers’ health and productivity. Factors that can predict musculoskeletal disorders can be thought of in three different categories: individual, ergonomic, and psychosocial factors.10

 The effects of an office ergonomics workplace and training intervention on workers’ knowledge can decrease work-related musculoskeletal disorders.8 Robertson & O’Neill found that training and workplace intervention would allow the worker to more effectively use their workplace through increased ergonomics knowledge, awareness and skills.8 Prognostic ergonomic and work technique factors for musculoskeletal symptoms among office workers have been evaluated with self-report questionnaires over the course of one-year after an educational intervention.9 This follow up study examined the frequency of musculoskeletal symptoms during the last 12 months in 5033 office workers within 11 companies.9 Overall, the subjects had a reduced frequency of symptom days in the neck, low back, shoulder, and elbow/hand.9 It was concluded that the identification of speed of work and hours of repetitive computer work were directly related to the prognostic factors for symptoms.9

 Mahmud et al. also concluded that ergonomic training reduced musculoskeletal disorders among office workers.10 Their intervention consisted of 2 training sessions that took place over a period of 1 day: the first consisted of lectures on office ergonomics, understanding the relationship between office ergonomics and the development of musculoskeletal disorders, ergonomic improvements and adjustments of workstations, and stretching exercises.10 The second session focused on the practical aspect of the training: trainers visited the participants’ workstations and provided assistance to them on how to adjust workstations effectively.10 After assessing workstation habits, musculoskeletal disorders, days and episodes of sick leave, and psychological well-being, they concluded a significant improvement in workstation habits, a 42.2% reduction in musculoskeletal disorders in the neck region, significant differences in the right shoulder, bilateral upper and lower limbs, and lower back during a 6-month follow up.10

 Another target area is to determine whether an ergonomic intervention affects the effectiveness of the office workers. Robertson et al. assigned four conditions to office workers which included flexible workspace (n=121), ergonomics training (n=92), flexible workspace + ergonomics training (n=31), and a no-intervention control (n=45).11 They collected outcome measures 2 months prior to the intervention and 3 and 6 months post-intervention.11 Overall, they concluded that the two intervention groups had significant effects on outcome variables when compared to the control group, including work-related musculoskeletal discomfort, job control, environmental satisfaction, sense of community, ergonomic climate, communication collaboration, and business process efficiency (time and costs).11

 Even more specifically, a hands on approach that consists of the assessment of an individual’s workspace and applies ergonomic modification can improve musculoskeletal symptoms. Robertson et al. examined the effects of office ergonomics training coupled with a highly adjustable chair on office workers’ knowledge and musculoskeletal risks.12 There were three groups: a group with training and adjustable chair (n=96), training only (n=63), and a control group (n=57).12 A pre- and post-training knowledge test was administered along with observed body postures and workstation set-ups to those who attended the training.12 Both intervention groups had a significant increase in overall ergonomic knowledge, control of physical work environment, and higher level behavioral translation and lower musculoskeletal risk compared to the control group.12

Areas that need more supporting evidence include the effects of office ergonomic training on sickness absence and psychological well-being.10 Mahmoud did not determine the impact of training on number of days missed from work and episodes of sick leave, or psychological well-being.10 They concluded that they did not adjust for confounding effects such as age, years of working with computers, or hours spent typing in their analysis of the effects of their intervention.10 Also recommended was for future studies to combine training and the use of adjustable furniture for office workers to reduce their risk of musculoskeletal disorders.10 There are consistent trends that support the role of chair intervention in reducing musculoskeletal symptoms among workers who are required to sit for prolonged periods.13 These trends contain further gaps, which include the effectiveness of chair intervention on long-term impact, particularly with musculoskeletal symptoms, as well as the recurrence of symptoms and the consequent cost of care.13

 With gaps including psychological well-being and episodes of sick days, we can examine the effects of our ergonomic education intervention using the International Classification of Functioning, Disability and Health (ICF) model. The ICF is a multi-purpose classification model that will help to describe changes in body function and structure, what a person with a health condition can do in a standard environment (their level of capacity), as well as what they actually do in their usual environment (their level of performance).14 The ICF can be used to improve capacity levels by focusing on actual performance of an individual or seek environmental modification, either by eliminating environmental barriers or creating environmental facilitators for expanded performance of actions and tasks in daily living.14 Ergonomic modification can help to decrease the risk of musculoskeletal disorders which can have negative effects on body structure and function, activity, and participation in office workers. Furthermore, the ICF can help to determine which factors need to be modified through our intervention program and the advantages they impose on the participants.

**Primary Goal/Objectives**

 The primary goal of “Ergonomics 101” is to decrease musculoskeletal injury rates in local Chapel Hill businesses through the education and intervention of appropriate ergonomic environments. The objectives for this initiative are:

1. To acquire baseline neck and back pain prevalence within participating local businesses using the Neck Disability Index (NDI) and the Oswestry Low Back Pain Questionnaire (OSW) prior to intervention for comparison with 3-month post-intervention outcomes.
2. To decrease the prevalence of neck and back pain in participants from baseline outcome values by the MCID (listed below) for the NDI and OSW 3 months post-intervention.
3. To provide participants with an ergonomic resource list during Phase I to benefit their overall environment and satisfaction in the workplace detected through the above-mentioned pre-intervention measures.
4. To educate participants about the evidence-based long-term health benefits of a more ergonomic work environment through 30-minute in-service during Phase I that will be evaluated by a 3 month post-intervention true/false survey.
5. To compare the number of missed workdays due to musculoskeletal injury for each participant 3 months pre-intervention and 3 months post-intervention to evaluate effectiveness of the ergonomic modification initiative.
6. To provide quarterly seminars on office ergonomics within local business in the Chapel Hill community that will be easily accessible to employees and employers.

**Proposed Intervention**

 “Ergonomics 101” will consist of two phases within local Chapel Hill businesses: an initial inservice and a 3-month follow-up visit. Prior to the first phase of intervention, baseline outcome measures will be administered to the participating employees in order to obtain a quantitative measure of neck pain, low back pain, and missed workdays. Phase one, the initial inservice, will consist of two parts: education on ergonomic workstations along with a hands-on training intervention. Additional resources will be provided to the employers on how to obtain items that will create a more ergonomic work environment for their employees. Phase two, the 3-month follow-up, will consist of gathering post-intervention outcome measures, which will be compared to baseline measures.

**Site Parameters**

This intervention will be provided four times a year by the UNC-DPT students who will visit two businesses two times each per year. Going to the business site will create an easily accessible program for the employees to gain many benefits. The first visit will consist of a one-hour presentation and interactive session with employers and employees. The second visit will be considered a follow-up to ensure compliance and overall improvement in the workplace. For larger businesses, the inservice will be provided for the first 50 people who sign-up.

**Pre-intervention: Initial Screening**

Participants will be provided with the Neck Disability Index (NDI) and Oswestry Low Back Pain Questionnaire to complete prior to the intervention. These self-report measures will provide baseline information about each participant’s musculoskeletal pain. The number of missed workdays for each participant will be requested upon the employer during the 3 months prior and 3 months following our intervention.

**Rationale for Selected Outcome Measures**

The Neck Disability Index (NDI) is a commonly used to capture perceived disability in patients with neck pain.19 The NDI contains 10 items, with 7 related to activities of daily living, 2 related to pain, and 1 related to concentration.19 Each item is scored from 0-5 with the total score expressed as a percentage, and the higher scores corresponding to greater disability.19 The NDI has been shown to have moderate test-retest reliability in subjects with mechanical neck pain.18,19 The MCID for the NDI has been shown as 7.017 and 8.5 points18 in studies on subjects with cervical radiculopathy, which could be present in this population. The MCID for subjects with mechanical neck pain is 9.5 points on the NDI.19 This will be important information to have when we consider if the intervention we provide has had an effect on the subjects, depending on the type of neck pain they are experiencing from the workplace. It will also help to identify how their neck pain has improved throughout their activities of daily living and overall concentration.

The Modified Oswestry Low Back Pain Disability Questionnaire (OSW) is a disease-specific self-report of a patient’s perceived disability based on ten areas of limitations in performance.20 The areas include pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social activity, traveling, and employment/ homemaking duties.20 Each section is scored on a six-point scale (0-5), with 0 representing no limitation and 5 representing maximal limitation, with a maximum score of 50 points.20 The total score is multiplied by two and expressed as a percentage, with a higher percentage indicating higher disability.20 The OSW has been shown to have an ICC of .90, GRI (Guyatt’s Responsiveness Index) of 3.49 and MCID of 6 points.21 The GRI is defined as the ratio of the average change in patients identified as improved divided by the standard deviation of the patients identified as remaining stable, with a larger GRI indicating greater responsiveness.21 Therefore, when compared with other low back pain questionnaires, the OSW has been shown to be more responsive, reliable, and valid.21 This self report measure will be time efficient, easy to administer, and will be able to detect change between baseline and follow-up measures in our sample.

**Phase I: Intervention Part I- Education**

A presentation of ergonomic research and basic education will begin this program. The aim is for the employers to continue to emphasize the need for an ergonomic workplace and support their employees with the education received.

**Rationale for Phase I: Part I**

Education on ergonomics has been shown to improve conditions in a population exposed to sitting postures for prolonged periods and inadequate furniture.15 For the working population, educational programs improve workstation set-ups, but the instruction program must be periodically reinforced to continue prevention of musculoskeletal pain.15 Another study found that educational programs reduce musculoskeletal disorders and ergonomic stressors in the workplace.16

**Phase I: Intervention Part II- Interactive Hands-on Session**

The next step in our initiative will be to provide an interactive hands-on session. This interactive session encourages employees to participate in scenarios of different desk set-ups and helps them problem solve together to improve the environments. Overall, the goal is to further educate employees on the short-term and long-term benefits of ergonomic changes in their workspace by physically interacting with various workplace environments.

**Rationale for Phase I: Part II**

There are many unidentified ergonomic deficiencies within a workstation of a typical office. Through an examination and modification in the participants’ workstations, we will be able to identify potential causes of their musculoskeletal problems. Of 40 workstations examined, 45% of the employees used nonadjustable chairs, 48% of computers faced windows, 90% of the employees used computers more than 4hrs/day, 45% of the employees adopted bent and unsupported back postures, and 20% used office tables for computers.22 Major problems were reported to be eyestrain (58%), shoulder pain (45%), back pain (43%), arm pain (35%), wrist pain (30%), and neck pain (30%).22 These serious ergonomic deficiencies in office computer workstation design, layout, and usage indicate that strategies to reduce or eliminate musculoskeletal injury are highly suggested.22 Overall, a comprehensive ergonomic program that includes a workstation adjustment, peer observation, and/or equipment trial will help to improve the postures and pain disability in desk job employees.23

**Phase II: 3-Month Follow-up**

There will be a 3-month follow-up visit to the participating businesses. During this time, a request will be made upon the employer to provide the number of missed workdays by each of the intervention participants. This visit will also ensure the compliance of the initial intervention and educational inservice by each participant and their corresponding workstations. The NDI and OSW measures will be re-administered to gather post-intervention data to compare to baseline results. When comparing pre-intervention and post-intervention missed workdays and musculoskeletal injuries, the goal of this phase is to detect meaningful changes that show the effects of the selected initiative. Additional modifications and suggestions may be made depending on the needs of the participants at this time. Future visits to a business may be planned to ensure the continuation of ergonomic environmental safety and musculoskeletal injury prevention.

**Rationale for Phase II**

 Ergonomic education programs can reduce musculoskeletal disorders developed in the workplace. An intervention that includes education and workstation modification has been shown to reduce musculoskeletal disorders most commonly in the neck region (reduced by 42.2%) during a 6-month follow-up.10 For participants with recent onset of musculoskeletal injury, an early intervention can target potential causes before they create chronic conditions. Those participants who do not improve due to chronic history of musculoskeletal disorders or the continuance of symptoms at the 3-month follow-up may consider referral to a physical therapist or their primary care physician.

**Evaluation**

 The focus of “Ergonomics 101” is to develop an ergonomic educational intervention program that targets the workforce in Chapel Hill. Evaluation of the proposed initiative will be implemented through the comparison of pre-intervention and the post-intervention outcome measures for each participant. Goal one and two will be evaluated at the completion of the intervention follow-up 3 months after the initial visit. This will be done by a comparison of the numerical data from pre- and post-intervention outcome measures (NDI and OSW) for each participant to detect any decrease in neck and back pain secondary to the ergonomic modifications made in the workplace. Goal three will be evaluated by the resource list provided to participants that includes literature conclusions as well as companies that sell ergonomic office products in which participants can order from for their desk space modifications. Goal four will evaluate the usefulness of the goal three resource list provided during the initial intervention by the post-intervention true/false survey that will consist of five questions. These questions will consist of information related to the initial in-service and hands on session as well as the ergonomic fact sheet to determine if participants gained knowledge from this initiative. Goal five will be evaluated using attendance records of the participant’s missed workdays related to musculoskeletal injury, which will be provided by their employers. The comparison of missed workdays 3 months prior to intervention with missed workdays 3 months post-intervention will be evaluated by the interpretation of any decrease in time missed as a positive result secondary to the proposed ergonomic initiative. This quantitative data will provide us with support for the ergonomic modifications made on decreasing musculoskeletal injury, thus reducing the amount of time missed from work. Lastly, goal six will be evaluated upon completion of the proposed intervention for each individual participating business. Thus, if each scheduled visit is fulfilled on time without delay, than the intervention timeline has been successful. If the participating businesses decide to continue their involvement with this initiative upon completion of the intervention timeline, recurring visits can be scheduled annually.

**Potential Barriers**

 There are several potential barriers to this initiative. Compliance of employers and employees is essential, but also something we are not able to control. The budget to provide ergonomic stations may not be feasible in some workplaces we visit. There may also be low attendance at the in-service presentations due to lack of motivation, indifference toward the topic, availability, and many other reasons. Missed workdays that we will be measuring could also be due to unforeseen events not related to the current focus of intervention.

 Many unknown features are involved in this proposal that could limit its success. We are unaware if companies will be willing to supply required resources to their employees or if the employees believe in the intervention’s effectiveness. This would cause our data to be unable to show significant changes in targeted issues due to non-compliance of obtaining resources and implementing ergonomic changes. Employees’ pain may be chronic, and this intervention strategy may not be enough to completely ameliorate these issues as it may be more of a preventative measure than treatment for prolonged conditions. Lack of improvement in musculoskeletal issues could prove to decrease productivity of businesses, frustrate employees, and have no return of investment for the employers.

**Relevance**

Musculoskeletal pain is common in the average office employee, particularly neck and back pain due to prolonged sitting and repetitive motions combined with poor workstation set-up3. Back and neck problems are the leading cause of job-related disability in the U.S.1. Findings from this proposal will enhance the overall satisfaction of the environment for employers and employees by decreasing musculoskeletal discomfort and lost workdays secondary to these impairments.

Workers within our UNC hospital and classroom community could benefit from these ergonomic changes as well. This initiative would be transferable to other settings within the UNC hospital system such as front desk workers, nurses’ workstations, and those who often perform documentation at a desk on a computer after treating a patient. It would also be relevant to any employee who performs data entry, performing long hours of repetitive tasks on a computer or school teachers and administration who spend time entering grades and communicating electronically in local private and public systems. In addition, other local business in Chapel Hill connected to our participating businesses would benefit from our program through word-of-mouth. This could be used as a model for implementation in nearby cities to decrease the prevalence of musculoskeletal issues and increase productivity of businesses.

**Resources:**

1. Strine TW, Hootman JM. US national prevalence and correlates of low back and neck pain among adults. *Arthritis Rheum*. 2007 May 15; 57(4): 656-65.
2. Musculoskeletal Disorders and Workplace Factors. A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. Edited by: Bruce P. Bernard. US Department of Health and Human Services. July 1997. http://www.cdc.gov/niosh/docs/97-141/pdfs/97-141.pdf
3. Woods, V. Musculoskeletal disorders and visual strain in intensive data processing workers. *Occup Med*. 2005 Mar; 55(2): 121-7.
4. Malinska M, Bugajska J. The influence of occupational and non-occupational factors on the prevalence of musculoskeletal complaints in users of portable computers. *Int J Occup Saf Ergon*. 2010; 16(3): 337-43.
5. <http://www.merriam-webster.com/dictionary/ergonomics> Accessed: 10/13/12.
6. Shaver EF, Braun, CC. The return on investment for human factors and ergonomics initiatives. Benchmark Research & Safety, Inc. 2008. <http://www.benchmarkrs.com/_uploads/The-ROI-Human-Factors-and-Ergonomics.pdf>. Accessed: 10/14/12.
7. Goggins RW, Spielholz P, Nothstein GL. Estimating the effectiveness of ergonomics interventions through case studies: implications for predictive cost-benefit analysis. *J Safety Res*. 2008; 39(3): 339-44.
8. Robertson MM, O’Neill MJ. Reducing musculoskeletal discomfort: effects of an office ergonomics workplace and training intervention. *Int J Occup Saf Ergon*. 2003; 9(4): 491-502.
9. Juul-Kristensen B, Jensen C. Self-reported workplace related ergonomic conditions as prognostic factors for musculoskeletal symptoms: the “BIT” follow up study on office workers. *Occup Environ Med*. 2005; 62(3): 188-94.
10. Mahmud N, Kenny DT, Md Zein R, Hassan SN. Ergonomic training reduces musculoskeletal disorders among office workers: results from the 6-month follow up. *Malays J Med Sci*. 2011; 18(2): 16-26.
11. Robertson MH, Huang YH, O’Neill MJ, Schleifer LM. Flexible workspace design and ergonomics training: impacts on the psychosocial work environment, musculoskeletal health, and work effectiveness among knowledge workers. *Appl Ergon*. 2008; 39(4): 483-94.
12. Robertson M, Amick BC, DeRango K, Rooney T, Bazzani L, Harrist R, Moore A. The effects of an office ergonomics training and chair intervention on worker knowledge, behavior and musculoskeletal risk. *Appl Ergon*. 2009; 40(1): 124-35.
13. Van Niekerk SM, Louw QQ, Hillier SS. The effectiveness of a chair intervention in the workplace to reduce musculoskeletal symptoms: a systematic review. *BMC Musculoskelt Disord*. 2012; 13(1): 145. [Epub ahead of print]
14. World Health Organization. Towards a common language for functioning, disability, and heatlh: ICF. 2002. Accessed 10/12/12: Retrieved from: <http://www.who.int/classifications/icf/training/icfbeginnersguide.pdf>.
15. Foltran FA, Moreira RF, Komatsu MO, Falconi MF, Sato TO. Effects of an educational back care program on Brazilian schoolchildren’s knowledge regarding back pain prevention. *Rev Bras Fisioter*. 2012 Apr; 16(2): 128-33.
16. Schierhout GH, Meyers JE, Bridger RS. Work related musculoskeletal disorders and ergonomic stressors in the South African workforce. *Occup Environ Med*. 1995 Jan; 52(1): 46-50.
17. Cleland JA, Fritz JM, Whitman JM, Palmer JA. The reliability and construct validity of the Neck Disability Index and patient specific functional scale in patients with cervical radiculopathy. *Spine*. 2006 Mar 1; 31(5): 598-602.
18. Young IA, Cleland JA, Michener LA, Brown C. Reliability, construct validity, and responsiveness of the neck disability index, patient-specific functional scale, and numeric pain rating scale in patients with cervical radiculopathy. *Am J Phys Med Rehabil*. 2010 Oct; 89(10): 831-9.
19. Cleland JA, Childs JD, Whitman JM. Psychometric properties of the Neck Disability Index and Numeric Pain Rating Scale in patients with mechanical neck pain. *Arch Phys Med Rehabil*. 2008 Jan; 89(1): 69-74.
20. Delitto A, Erhard RE, Bowling RW. A treatment-based classification approach to low back syndrome: Identifying and staging patients for conservative treatment. *Physical Therapy*. 1995; 75(6): 470-489.
21. Fritz JM, Irrgang JJ. A comparison of a Modified Oswestry Low Back Pain Disability Questionnaire and the Quebec Back Pain Disability Scale. *Physical Therapy*. 2001; 81: 776-788.
22. Shikdar AA, Al-Kindi MA. Office ergonomics: deficiencies in computer workstation design. *Int J Occup Saf Ergon*. 2007; 13(2): 215-223.
23. Gravina N, Lindstrom-Hazel D, Austin J. The effects of workstation changes and behavioral interventions on safe typing postures in an office. *Work*. 2007; 29(3): 245-253.