OCCUPATIONAL HEALTH

SPECIAL INTEREST GROUP

The Occupational Health Special Interest Group serves as a resource for members involved in the field of Occupational Health Physical Therapy. The Special Interest Group is happy to direct you to their first podcast produced by Chris Studebaker. Check out the Orthopaedic Section website under the OHSIG to access the podcast and previous literature reviews and articles of interest for members.

http://www.orthopt.org/content/special_interest_groups/occupational_health/news_from_your_ohptsig

Meetings and conferences of interest for members may be listed on the SIG website by sending information to lpettet@aol.com.

Work Disability Prevention and Integration Conference

The Work Disability Prevention and Integration (WDPI) Biennial Conference serves as an international forum for research and knowledge implementation related to work disability prevention and integration, across all causes of work incapacity. Participants include the leading international experts in the field--scientists, health care and rehabilitation providers, employers, human resource managers, public and private insurers, lawyers, and policymakers. The first WDPI meeting was held in 2010 in Angers (France) and the second in 2012 in Groningen (The Netherlands), attracting 200 delegates from 25 countries all over the world. This year we received the largest response ever to the call for abstracts, leading to an excellent conference featuring the most recent scientific developments in the WDP field. The course was held September 29-October 1, 2014 at the Hyatt Regency Hotel in Toronto (http://www.wdpi2014.iwh.on.ca/).

Is Perching the New Paradigm? The Assessment of a New Working Posture

Carisa Harris Adamson, PhD, PT,[1] Jessica Bailey, SPT,[1] Andrew Smith, PhD[2]

[1]Department of Physical Therapy, Samuel Merritt University, Oakland, CA
[2]Motion Analysis Research Center, Samuel Merritt University, Oakland, CA

INTRODUCTION

The dramatic rise in occupational sitting time over the past 30 years has been well documented[1,2] and largely attributed to a shift away from agricultural jobs toward sedentary jobs created by the technology boom. Since the adoption of the computer, sitting time at work has increased from an average of 3.4 hours to 6.3 hours per day.[2] Concurrent increases in non-active leisure activities, including driving, has compounded the lack of occupational physical activity. For example, sedentary leisure time spent viewing television (TV) alone has doubled since 1950.[1] This is an alarming number given that Owen et al[3] found a dose-response relationship between TV viewing time and metabolic risk factors such as waist circumference, systolic blood pressure, and blood bio markers.[3] Overall, because of occupational and leisure activities, individuals spend an average of 7.7 hours per day being sedentary.[4] The associations between this increasingly sedentary lifestyle and increased rates of metabolic (eg, obesity, type 2 diabetes, altered lipoprotein lipase), cardiovascular (eg, hypertension, venous thromboembolism), and musculoskeletal disorders (eg, low back and neck pain) is recognized as a public health issue;[5] thus, solutions that reduce prolonged sitting are warranted. The purpose of this paper is to describe the various health risks associated with prolonged sitting, review workplace solutions, and highlight a new type of sitting worthy of investigation.

METABOLIC AND CARDIOVASCULAR IMPLICATIONS FROM PROLONGED SITTING

Reduced Exercise Activity Thermogenesis

Obesity has risen due to highly accessible, inexpensive energy-dense foods and concurrent physical inactivity.[6] Two-thirds of the population are overweight (BMI >25 kg/m^2) and one-third are obese (BMI>30 kg/m^2), problems attributed to a persistent positive energy balance as small as 100 kcal/day.[6] Since obese individuals tend to be sedentary at least 2.5 hours per day more than fit individuals,[7] there has been a focus on increasing workers' moderate to vigorous physical activity outside of the workplace. Employers have funded workplace wellness programs to guide physically inactive individuals toward a more active lifestyle. However, a study by Green et al8 assessed the success of a 10-week workplace program and found that despite a short-term increase, physical activity levels were not different at the 6-month follow-up due to busy work and home schedules. This was validated by Kruger and colleagues,[9] who stated the most common reasons for not participating in worksite wellness programs were lack of time before, during, and after work.

Despite the challenges in promoting more moderate to vigorous activity in workers, it is possible that prolonged, low nonexercise activities such as sitting cannot actually be offset by moderate to vigorous exercise. A study by Katzmarzyk et al[10] showed a dose response relationship between increased sitting time and risk of disease. Sedentary individuals had up to a 50% increase in mortality due to cardiovascular or metabolic diseases, even among those individuals who engaged in physical activity. This supports the notion that excessive sedentary time, regardless of physical activity, is an independent risk factor for diseases such as obesity and cardiovascular disease.

Reduced Nonexercise Activity Thermogenesis

According to work by Hamilton et al,[11] one adverse consequence of physical inactivity could be the down regulation of the enzyme lipoprotein lipase (LPL) found to be associated with obesity, type 2 diabetes, and coronary heart disease.[11,12] Given that the typical engagement in moderate to vigorous physical activity may not be enough to prevent the down regulation of LPL, researchers have studied other methods of thermogenesis. The thermogenesis required to complete everyday tasks, with the exception of intentional exercise, has been termed as nonexercise activity thermogenesis (NEAT), and has been linked with increased energy expenditure.[13-15] Since more than 58 million people in the United States alone have sedentary jobs, finding ways to increase NEAT at work may be advantageous for preventing the incidence and severity of cardiovascular and metabolic diseases.[16]

Levine et al[13] assessed the thermogenic potential of low activity fidgeting while sitting and standing to see if it could contribute to an individual's energy balance. According to the authors, when compared with the metabolic rate in a supine position (5.4 ± 1.5 kJ/min), fidgeting increased energy expenditure by over 50% versus only a 4% increase while sitting. The difference was even larger when comparing standing while fidgeting (94%) to standing alone (13%). For comparison, walking at 1.6 km/h increased the metabolic rate by 154% over resting in supine. Therefore, implementing the World Health Organization's recommendation to increase energy expenditure by 834 kJ/d (200 kcal/d) would be equivalent to an obese individual partaking in a fidgeting-like activity of 2.5 h/d or strolling-equivalent activity of 1 h/d.[13] Therefore, increasing energy expenditure (NEAT) through everyday tasks, such as occupational sitting, may be an important way to maintain good health by potentially reducing down regulation of LPL associated metabolic and cardiovascular diseases.[11]

MUSCULOSKELETAL IMPLICATIONS FROM PROLONGED SITTING

Prolonged static sitting also has important implications for the musculoskeletal system. Sixty percent of office workers complain of physical discomfort[17] with sitting thought to be a main cause.[18] The L4/L5 compressive forces are higher by an average of 500N in sitting versus standing with a similar pattern seen for anterior/posterior (A/P) shear forces.[19] Although both positions are well below the NIOSH tissue tolerance limit of 3400N and 500N,[19,20] prolonged low level static compressive and shear forces can be problematic.[19] Additionally, the human body requires movement to nourish its structures such as the intervertebral discs[19-22] and to facilitate varying muscle pattern recruitment to prevent physiological muscle fatigue.[21-23] Static muscle contractions result in fatigue and discomfort with only 2% of one's maximum voluntary contraction (MVC) being the recommended limit for sustained static muscle tension (contraction).[21] Sustained tension in the neck and shoulder muscles during computer use has been identified as a predisposing factor for the development of pain.[22] Therefore, much attention has been focused on the development of work positions that reduce prolonged static postures thus minimizing physiologic and biomechanical loads.

Andersson and colleagues[24] measured muscle activity of the trunk in upright and reclined postures while sitting and standing. Electromyography results found that lumbar supports and increased seat angle (reclined position) reduced trunk muscle activation levels. A study by Schuldt et al[25] showed that a whole spine flexed posture versus an upright one (neutral spine) increased static neck and shoulder muscle activity, both of which were reduced if the sitting position was reclined. Although a reclined position and/or chair support can reduce static muscle loads, people tend to lean forward and not use back or forearm supports when engaging in computer work,[26] lessening the benefits of both.

In addition to position, one's posture while sitting or standing may be an important determinant of physiological and biomechanical load. O'Sullivan[27] compared sway stance and slump sitting to upright (neutral spine) standing and sitting. Both sway and slump postures are strategies adopted to reduce workload on the muscles, thereby reducing energy consumption. These postures also increase stress on passive (noncontractile) structures, such as lumbar discs and ligaments, that may lead to low back musculoskeletal disorders (MSDs) or exacerbate MSD symptoms.[27,28] Similar to slump sitting, a decrease in activation of the superficial lumbar multifidus, internal oblique, and thoracic erector spinae muscles was observed during sway standing. Therefore, adopting more upright work postures may use a more active system thereby reducing stress on passive structures that can become painful when under prolonged static loads.[29]

In summary, prolonged static sitting has implications for the metabolic, cardiovascular, and musculoskeletal systems and it has contributed to diseases of epidemic proportions for the enormous number of people with sedentary jobs. Increasing moderate to vigorous physical activity is not always practical nor independently effective in reducing risk of health disorders from being sedentary. NEAT appears to be effective at increasing metabolic activity and maintaining LPL function. Changing positions and postures positively impacts the musculoskeletal system by reducing static muscle tension and increasing nourishment of noncontractile structures. Therefore, increasing NEAT through changes in position and posture may positively impact the health of those with sedentary jobs who are at increased risk for metabolic, cardiovascular, and musculoskeletal disorders.

SOLUTIONS

Exercise While at Work

Attempts to reduce prolonged static seating have been made by incorporating stair steppers and treadmills into computer work stations. McAlpine and colleagues[30] developed an officeplace stepping device for use under a desk and showed an average increase in energy expenditure above sitting by 289 or 102 kcal/hour in fit individuals and 335 or 199 kcal/hour in obese individuals. Treadmill workstations were devised to allow users to alternate between sitting and walking while working. However, like stair stepping, walking while working required workers to perform two or more tasks at a time. In addition to gross motor tasks, workers simultaneously engaged in cognitive tasks, such as calculating, comprehending, interpreting, and problem solving. However, concern about dual task cost, or dividing attentional resources between treadmill walking and office work that may compromise work performance, limited its use. Recently, the research on NEAT, which showed that low-level activities might help control weight[13] revived the idea of using treadmill workstations. In fact, a study by Levine and Miller[15] found that if obese individuals walked 2 to 4 hours per workday at about 1 mph, daily energy expenditure would increase by about 500 kcal per day causing a weight loss of 20 to 30 kg/year.[15]

To determine the potential impact of treadmill workstations on productivity and the quality of work, a study by John et al[31] assessed cognition and processing tasks (reading and math) as well as computer interface tasks (mousing and typing). They found a slight decrease in typing and mousing efficiency and a 6% to 11% decrease in fine motor skills and math problem solving. There were no significant differences in selective attention and processing speed or reading comprehension. Ohlinger and colleagues[32] found that the addition of low-intensity walking did not negatively affect performance on cognitive tasks, but it did affect motor tasks.[32] Straker et al[14] also found that typing performance was diminished during walking, with a 6% decrease in actual typing speed and a 17% decrease in perceived typing speed when compared to sitting.[14] Mouse performance also diminished while walking, with a 14% in actual and a 26% decrease in perceived mouse pointing speed compared to sitting. Of concern was the 106% increase in mouse pointing error rate while walking. Cycling while working was also assessed and had just slightly lower decrements for typing and mousing performance than walking.[14] Although activities like stair stepping, cycling, and even walking are highly practiced, they are not automatic and can have a negative impact on other concurrently performed tasks.

Although the suggested benefits of walking just 25% of the workday may be worth offsetting the increased health risks associated with prolonged static sitting,[13] there are some practical aspects to consider. First, for individuals who are completing tasks that require high cognition, they may not be able to afford reductions in productivity.[33] The high cost and space requirements of treadmill or bicycle workstations make them less appealing for employers to implement. Finally, the adoption of such workstations by workers remains questionable.

The Sit-Stand Paradigm

The sit-stand paradigm emerged to provide relief and rest for both passive and active structures in the spine while eliminating the challenges associated with exercise workstations. The criticality of pauses and variation of loads for physiological and biomechanical benefits have been well documented.[19,34,35] The goal of the sit-stand paradigm is to optimize the benefits of both sitting and standing into one workday. Sitting provides stability and support to the torso, allowing for proximal fixation with distal precision of upper extremity movements. Standing allows for variation in loads compared to sitting, with more demand on the circulatory system and muscles of the lower extremities and back. Standing for part of the workday has been recommended to reduce work-related MSD complaints associated with sitting.[36] Husemann et al[36] increased standing time of participants by 25% throughout the workday using sit-stand desks and found that there were fewer physical complaints.[36] And, although it has been suggested that standing could enhance cognitive performance, stimulation, and awareness through activation of the cardiovascular system,[37-39] there actually has been some evidence of dual-task cost detriments with standing.[36,40] Most importantly, there was poor compliance with the sit-stand workstation paradigm.[41] So although sit-stand workstations offer variability in work positions and postures, they are typically underused due to perceived difficulty and/or forgetting to make such adjustments in work posture settings.

Dynamic Sitting through Perching-The New Paradigm?

Perching is a term that describes a position that is between sitting and standing (Figure 1). A new workstation design offers a seat pan that tilts freely on a support stick that has a mobile attachment to a base on the floor. The user leans or perches on the seat, assuming an open hip angle of approximately 135°, which facilitates an anterior tilt of the pelvis. The perching posture prevents slump sitting and sway stances facilitating a more vertical spine (see Figure 1). The user must balance on the seat pan putting pressure through both feet, increasing the dynamic nature of the position. The desk is large and has a flare similar to a cutout to allow for upper extremity support (Figure 2) that may help reduce negative impact of sustained neck and shoulder tension.[42] It can be positioned flat or tilted toward the user. The dynamic aspect of perching may help increase NEAT by providing some benefit to offset the cardiovascular and metabolic risks that sedentary workers face.

However, there could be drawbacks to perching as well. It is possible that the position shifts loads from passive structures in the spine to those in the knees and/or hips since there is sustained pressure through the lower extremities. The lack of back support may cause excessive prolonged strain on active structures in the spine and the small seat pan could place excessive contact stress on the thighs, thus restricting blood flow in the legs. Finally, it is unknown whether an increase in NEAT is substantial enough to help increase the overall energy balance, and whether it can do so without negatively affecting cognition and performance. More research is needed to assess whether perching itself can be the new paradigm, or whether it can be part of a new sit-perch-stand paradigm that will positively impact the "sitting disease" epidemic.

QUANTITATIVE ASSESSMENT OF PERCHING

The first step in the assessment of perching is to refine measurements that can detect differences between the biomechanical and physiological requirements of perching versus sitting and standing. Further research should explore:

- Oxygen consumption and heart rate across various postures.
- Venous blood flow and pressure mapping to assess the contact pressure at the seat pan.
- Motion analysis studies to assess:
  - o the amplitude and distribution of center of mass movement;
  - o joint angles of the knee, hip, shoulder, and spine; and
  - o shear and compressive forces on the spine and lower extremity joints.
- EMG to assess activity of the:
  - o lumbopelvic stabilizer muscles
  - o lower extremity muscles (quadriceps, hamstrings and gastroc/soleus), and
  - o neck/shoulder muscles (upper trapezius and deltoid).

If findings are favorable to perching, additional research will be needed to assess positive or negative implications on cognition and computer use. Further research will also be needed to assess comfort, preference, and usability. Finally, it is highly possible that perching itself is not the new paradigm, yet part of a paradigm that specifies a recommended amount of sitting, perching, and standing throughout the day that may vary by task and user goals.

Figure 1. An example of a perching versus sitting using the Focal Locus Seat (www.focaluprightfurniture.com/).

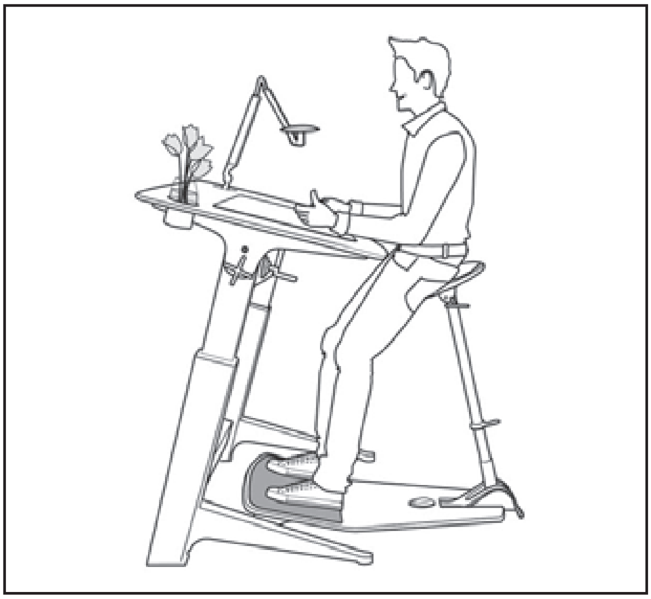

Figure 2. An example of forearm support while perching using the Locus Workstation.

REFERENCES

1. Brownson RC, Boehmer TK, Luke DA. Declining rates of physical activity in the United States: what are the contributors? *Annu Rev Public Health*. 2005;26:421-443.
2. Chau JY, van der Ploeg HP, Merom D, Chey T, Bauman AE. Cross-sectional associations between occupational and leisure-time sitting, physical activity and obesity in working adults. *Prev Med*. 2012;54(3-4):195-200.
3. Owen N, Healy GN, Matthews CE, Dunstan DW. Too much sitting: the population health science of sedentary behavior. *Exerc Sport Sci Rev*. 2010;38(3):105-113.
4. Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003-2004. *Am J Epidemiol*. 2008;167(7):875-881.
5. U.S. Centers for Disease Control and Prevention. Quick facts: Economic and health burden of chronic disease. ttp://www.cdc.gov/physicalactivity/index.html. Accessed August 22, 2014.
6. Swinburn BA, Caterson I, Seidall JC, James WP. Diet, nutrition and the prevention of excess weight gain and obesity. *Public Health Nutr*. 004;7(1A):123-146.
7. Levine JA, Lanningham-Foster LM, McCrady SK, et al. Interindividual variation in posture allocation: possible role in human obesity. *Science*. 2005;307:584–586.
8. Green BB, Cheadle A, Pellegrini AS, Harris JR. Active for life: a work-based physical activity program. *Prev Chronic Dis*. 2007;4(3):A63.
9. Kruger J, Yore MM, Bauer DR, Kohl HW. Selected barriers and incentives for worksite health promotion services and policies. *Am J Health Promot*. 2007;21(5):439–447.
10. Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Med Sci Sports Exerc*. 2009;41(5):998-1005.
11. Hamilton MT, Hamilton DG, Zderic TW. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes*. 2007;56(11):2655–2667.
12. Zderic TW, Hamilton MT. Physical inactivity amplifies the sensitivity of skeletal muscle to the lipid-induced downregulation of lipoprotein lipase activity. *J Appl Physiol*. 2006;100:249–257.
13. Levine, JA, Schleusner SJ, Jensen MD. Energy expenditure of nonexercise activity. *Am J Clin Nutr*. 2000;72:1451-1454.
14. Straker L, Levine J, Campbell A. The effects of walking and cycling computer workstations on keyboard and mouse performance. *Hum Factors*. 2009;51(6);831-844.
15. Levine JA, Miller JM. The energy expenditure of using a "walk and work" desk for office workers with obesity. *Br J Sports Med*. 2007;41:558-561.
16. King GA, Fitzhugh EC, Bassett DR, et al. Relationship of leisure-time physical activity and occupational activity to the prevalence of obesity. *Int J Obes Relat Metab Disord*. 2001;25(5):606–612.
17. Spyropoulos P, Papthanasiou G, Georgoudis G, Chronopoulos E, Koutis H, Koumoutsou F. Prevalence of low back pain in Greek public office workers. *Pain Physician*. 2007;10(5):651-659.
18. 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):188-194.
19. Chaffin DB, Andersson GB, Martin BJ. *Occupational Biomechanics*. New York: Wiley-Interscience; 1999:394–395.
20. Wilder DO, Pope, MH. Epidemiological and etiological aspects of low back pain in vibration environments-an update. *Clin Biomech*.1996;11(2):61-73.
21. Jonsson B. The static load component in muscle work. Eur *J Appl Physiol*. 1988;57:305-310.
22. Andersson B, Ortengren R, Nachemson AL, et al. The sitting posture: an electromyographic and discometric study. *Orthop Clin North Am*. 1975;6:105–120.
23. Veierstred KB, Westgaar RH, Andersen P. Pattern of muscle activity during stereotyped work and its relation to muscle pain. *Int Arch Occup Environ Health*. 1990;62:31-41.
24. Andersson E, Oddsson L, Grundstrom H, et al. EMG activities of the quadratus lumborum and erector spinae muscles during flexion–relaxation and other motor tasks. *Clin Biomech*. 1996;11:392–400.

25. Shuldt K, Ekholm J, Harms-Ringdahl K, Nemeth G, Arborelius UP.Effects of changes in sitting work posture on static neck and shoulder muscle activity. *Ergonomics.* 1986:29(12);1525-1537.
26. Callaghan JP, McGill SP. Low back joint loading and kinematics during standing and unsupported sitting. *Ergonomics.* 2001:44(3);280-294.
27. O'Sullivan PB. Lumbar segmental 'instability': clinical presentation and specific stabilizing exercise management. *Man Ther.* 2000;5:2–12.
28. Cholewicki J, McGill S. Mechanical stability of the in vivo lumbar spine: implications for injury and chronic low back pain. *Clin Biomech*. 1996;11:1–15.
29. Harms-Ringdahl, K., Ekholm, J. Intensity and character of pain and muscular activity levels elicited by maintained extreme flexion position of the lower-cervical-upper-thoracic spine. *Scand J Rehab Med*. 1986;18:117–126.
30. McAlpine DA, Manohar CU, McCrady SK, Hensrud D, Levine JA. An office place stepping device to promote workplace activity. *Br J Sports Med*. 2007;41:903-907.
31. John D, Bassett D, Thompson D, Fairbrother J, Baldwin D. Effect of using a treadmill workstation on performance of simulated office work tasks. *J Phys Act Health*. 2009;6:617-624.
32. Ohlinger, CM, Horn TS, Berg WP, Cox, RH. The effect of active workstation use on measures of cognition, attention, and motor skill. *J Phys Act Health*. 2011;8:119-125.
33. Thompson WG, Levine JA. Productivity of transcriptionists using a treadmill desk. *Work.* 2011;20:473-477.
34. Veiersted KB, Westgaard RH, Andersen P. Electromyographic evaluation of muscular work pattern as a predictor of trapezius myalgia. *Scand J Work Environ Health.*1993;19:284–290.
35. Kraemer J, Kolditz D, Gowin R. Water and electrolyte content of human intervertebral discs under variable load. *Spine*. 1985;10(1):69–71.
36. Husemann B, Von Mach CY, Borsotto D, Zepf KI, Scharnbacher J. Comparisons of musculoskeletal complaints and data entry between a sitting and a sit-stand workstation paradigm. *Hum Factors*. 2009;51(3):310-320.
37. Watanabe N, Reece J, Polus BI. Effects of body position on autonomic regulation of cardiovascular function in young, healthy adults. *Chiropr Osteopat*. 2007;15(19):1–8.
38. Caldwell JA, Prazinko B, Caldwell JL. Body posture affects electroencephalographic activity and psychomotor vigilance task performance in sleep-deprived subjects. *Clin Neurophysiol.* 2003;114:23–31.
39. Elliott L, Coleman M, Shiel A, et al. Effect of posture on levels of arousal and awareness in vegetative and minimally conscious state patients: A preliminary investigation. *J Neurol Neurosurg Psychiatry*. 2005;76(2):290-300.
40. Pashler H. Dual-task interference in simple tasks: Data and theory. *Psychol Bull*. 1994;116:220–244.
41. Wilks S, Mortimer M, Nylen P. The introduction of sit-stand worktables: Aspects of attitudes, compliance and satisfaction. *Appl Ergon*. 2006;37:359–365.
42. Aaras A, Fostervold KI, Ro O, Thoresen M, Larsen S. Postural load during VDU work; a comparison between various work postures. *Ergonomics*. 1997;40(11):1255–1268.