

Novel suggestions on sitting workplace ergonomics

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Chairs, chair to desk ratio, armrests, leg support, keyboard position and other “measurements” are certainly important considerations, but it really should be viewed as more than just physical angles and assigned positions. We are a living, breathing organism which requires movement for our system to function optimally. The body is constantly pumping fluids, gasses, electrical signals—energy—to our brain and the rest of the body in an effort to maintain homeostasis as best as possible throughout our day. Sitting or standing for extended periods of time makes us lose this ability to pump as effectively, compromising the balance the body is trying to achieve. Arms and/or legs that are alternating, shifting weight from side-to-side such as occurs with walking, is what keeps these pumps active inside us.

Static workstation positions create physical stress onto the system a few different ways: it increases passive tissue tension, increases joint and intravertebral disc compression, decreases fluid and respiratory exchange, creates a more myopic visual field, and decreases the inherent contractile qualities of some muscles while increasing activity of global vs local muscles. Our psychological system will then respond, often subconsciously, by sensing this stress on the body and then the other conscious stressors (i.e. work requirements, job pressures) feed into it further. Now we have a more sympathetic, heightened baseline to function from and it becomes increasingly difficult to correlate what is happening to us insidiously throughout the day (i.e. how we position ourselves) as a major contributor of this.

While it might make sense in theory to utilize workstations which would allow us to move more consistently, (i.e. treadmill workstations, stationary bike workstations, sitting on physioballs), having the body try and coordinate mental tasks and stabilize the visual and vestibular system while trying to ambulate on a treadmill or stationary cycle or constantly stabilize itself on an unstable surface will not be successful for very long and would likely lead to other issues.

It’s also important to take into consideration how one sets themselves up at home for doing work at a computer or other such task. Far too often we will sit on a couch, a bed, or a seat which we feel is comfortable to do work, but it was really meant for socializing, reading or (far too often) watching television. What our brain perceives as “comfortable” is often not optimal and often can be detrimental.

The following recommendations are things to consider regarding workplace human factors based on a combination of clinical experience, human physiology, biomechanics, and available research and resources. Adaptations might need to be introduced based on the individual and/or the work environment. There are far too

many factors to determine one ideal position for everyone as there are biopsychosocial considerations as well which make each situation somewhat unique. *[Author's note: I have tried to not "cherry-pick" studies to support any particular concepts, but the multitude of research available, often with conflicting information, required me to have to prioritize the information based on the other listed resources.]*

The two key points to note with these recommendations are: **variability** and **movement**. **Variability** because changing up how we position our structure during the day is optimal and having options to allow for this is key. **Movement** because while our system was designed for movement, our brain was designed for efficiency, so it will always try and take the easy way out, which usually means move less and support more.

Positioning considerations

- Sitting:
 - Chair:
 - Should allow the ability to have feet flat on the floor, be able to put weight through the heels, with the shins at a small negative angle or just a little past vertical.
 - The left heel often needs a little more attention to keep weight through it.
 - Use a book or block to raise the floor if needed (yes, raise the floor to help create pressure from below to load onto, not to support the feet and push the body further into the seatback).
 - Wearing heels while sitting does not allow for proper positioning of the pelvis and hips. While it may seem helpful for some, it will have a tendency to load the wrong muscles for sitting and increasing even more when going from sitting to standing, (*Influence of high-heeled shoes on the quadriceps electromyographic activity in women with and without patellofemoral pain syndrome during the sit-to-stand task.* L Batistat, et al. *Fisioter Pesq.* 2013;20(1):2-10.)
 - Consider having another pair of shoes at one's workstation to wear when sitting or standing for extended periods of time.

- Adjusting a workstation to accommodate wearing heels is a compensation and can potentially lead to other problems.
- Ideally, the seat-bottom should not touch the back of the lower legs but come close.
 - If the seat is hitting the backs of the lower legs too much, it will pull on the legs, not allowing the low back/sacrum to *rest*—not just touch—against the chairback.
 - The front edge of the chair can be helpful at times in providing resistance (kicks in proximal hamstrings) when actively trying to position on the chair.
 - The seat (pan) length is an important consideration for those with shorter legs. Too many chairs are designed for people who are 5’8”.
 - There are conflicting findings in the research as to whether it is better to have the pan tipped forward a little or not at all. Some feel a little wedge or forward tip can help a lot, while other research suggests it increases tissue and perceived tension.
 - Varying the position of the seat periodically during the day can be helpful. Sit away from the back of the chair with more weight through the legs when it is tipped forward a little and gently rest the back against seatback when it is more level.
- Much of the research suggests that knees should be at the level of the hips or just below.
 - Seat back angles of about 110 degrees seems to allow the least amount of compression onto the discs and spinal muscles, but it also decreases the overall muscle activity for performing even menial tasks which require the ability to move and decreases the ability to be able to reach with the appropriate musculature.
- Your legs to be able to move your hips and pelvis forward and back (anterior/posterior “tilting”) and independently on each side (rotating or “shifting” pelvis on one side then the other). This allows for the ability to make adjustments of lower to upper body position.
- You should feel your ischial tuberosities (“sitz bonez”, butt bones).

- Weight should be felt through these bones more than the back of the thighs.
 - The left side often requires a little more attention to weight through this.
 - Armrests should be adjustable to allow for the arms to be able to rest comfortably with forearms fairly parallel and not limiting movement of the wrists.
 - While armrests have been shown to be beneficial in reducing the forearm, trapezius and erector spinae muscle activity, they will also reduce freedom of thoracic mobility and the use of the oblique, deep abdominal and intercostal muscles.
 - (Workplace risk factors and occupational musculoskeletal disorders, Part 2: A review of biomechanical and psychophysical research on risk factors associated with upper extremity disorders. AIHAJ. 2000 Mar-Apr;61(2):231-43. Review. Work-Related Musculoskeletal Disorders: Report, Workshop Summary, and Workshop Papers)
 - Varying the use of armrests periodically during the day can be helpful. Utilizing them when doing more keyboarding and computer work and dropping them when doing other tasks.
 - Try to limit crossing one ankle over the other with the feet under the chair (Tailor sitting), sitting cross-legged or sitting on one ankle.
 - Periodically sit more on the front edge of the seat.
 - This allows for a bit more load to be placed through the ischial tuberosities and the feet loaded into the floor. This helps promote “relaxed” sitting in which there is a fair amount of balanced muscle work and airflow.
 - Sitting should allow for full circumferential expansion of the ribs upon inhalation and support the ability to exhale a little more fully which requires the pelvis being able to posteriorly tilt a little when exhaling.
 - Lumbar supports, especially the more aggressive they are, do not allow for this balanced airflow.
- Self-checking:
 - You should be able to feel the deep abdominals and shoulder blade (scapular) muscles *lightly* working when in sitting.

- The position you are in should allow this to occur easier vs. feeling like you have to actively tighten those areas much.
 - You should be able to inhale and feel the ribs expand circumferentially—in particular the back being able to expand into the seat back.
 - A thorax (ribcage) which is well-positioned will allow for full expansion without having the shoulders rise and fall much on inhalation.
 - Periodically during any sitting session, slide your left thigh back and actively bring your left middle back against the seatback and inhale into this area for a few breaths. You should feel the left abdominals helping push you back against the chair while performing this. This helps with balancing out our innate imbalanced breathing patterns.
 - Reach Test: When sitting comfortably, if one arm reaches forward and across the body, you should feel the rotation happening more in the ribcage without much activity in the neck or low back. If more activity or even light strain is felt in the neck and/or low back, than:
 - You are not in an optimal seated position to function, even for more inactive tasks such as computer work.
 - Your system is not in an optimally balanced position (i.e. respiratory tone has increased, pressure in the body is not optimal).
 - Perform the 5 Breath Reset to help restore this balanced position.
 - Breaking Inertia Test: When sitting comfortably, you should be able to feel like it is easy to pull your back off the chair with very little muscle work.
 - If the back and/or neck muscles are perceived as helping lift off, then you are not in optimal position.
- Other considerations:
 - Wearing shoes where you can feel an arch of the shoe and the shoe has a back to it is best.
 - Feet need to be able to plant and have some traction.
 - Heels are not optimal for maintaining good seated position.
 - There shouldn't be too much weight through the wrists, but it should allow the ability to put light pressure through the elbows on the armrests.

- Periodically lightly press down through your elbows into the armrests so you feel your abdominals engage (not low back or neck) and hold this while taking 3 or 4 full breaths in and out.
- Use a kitchen timer to buzz so that you get up every 20-30 minutes to take a brief walk.
- If not able to get up, at least look up from your computer out a window, down a hallway, out a doorway, etc. so that you modify your gaze periodically.

From the research:

- Ergonomics, or human factors, is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.
- “Although individual variation was sizeable, the results showed clear postural behaviour differences between the various work tasks. Work tasks which have a higher incidence of musculo-skeletal disorders were found to produce less frequent and less marked postural change.”
 - An assessment of seated activity and postures at five workplaces. M. Graf, U. Guggenbühl, H. Krueger. International Journal of Industrial Ergonomics, Volume 15, Issue 2, February 1995, Pages 81-89.
- “The basic goal of ergonomics is to achieve an optimal fit between the individual, the task being accomplished, and the tools needed to complete the task. The purpose of achieving an optimal fit is to simultaneously enhance the individual’s productivity, satisfaction, comfort, and health.”
 - Interventions, Controls and Applications in Occupational Ergonomics. Marras W, Karwowski W, eds. 38.6.1, p. 38-12.
- “Standing appears to be a good rest from sitting given the reduction in passive tissue forces. However, the constant loading with little dynamic movement which characterizes both standing and sitting would provide little rest/change for muscular activation levels or low back loading.”
 - Low back joint loading and kinematics during standing and unsupported sitting. Ergonomics, Vol. 44, 2001. J. P. Callaghan & S. M. McGill, pp 280-294.
- “Of the sample, 55% participants reported LBP in standing. A stand to sit ratio of 3:1 did not provide lasting recovery of LBP from standing and pain developers

utilized a limited range of their lumbar spine angle and increased thoracic extension, resulting in static postures that caused tissue aggravation that was not resolved after 15 minutes of sitting. Prolonged standing in the workplace has the potential to result in LBP for some workers and alternate ways to reduce sedentary time should be investigated.”

- The influence of a seated break on prolonged standing induced low back pain development. Kaitlin M. Gallagher, Troy Campbell & Jack P. Callaghan. *Ergonomics*, 2014; Vol. 57, pp 555-562.
- “Standing without freedom to sit was associated with LBP. Different occupational physical and psychosocial factors were associated with LBP in sitting compared with standing populations.”
 - Studying the relationship between low back pain and working postures among those who stand and those who sit most of the working day. F. Tissot , K. Messing & S. Stock, *Ergonomics*, 2009; Vol 52, Issue 11, pp 1402-1418.
- “Subjects in seats with backrest inclinations of 110 to 130 degrees, with concomitant lumbar support, have the lowest disc pressures and lowest electromyography recordings from spinal muscles. A seat-bottom posterior inclination of 5 degrees and armrests can further reduce lumbar disc pressures and electromyography readings while seated. To reduce forward translated head postures, a seat-back inclination of 110 degrees is preferable over higher inclinations. Work objects, such as video monitors, are optimum at eye level. Forward-tilting, seat-bottom inclines can increase lordosis, but subjects give high comfort ratings to adjustable chairs, which allow changes in position.”
 - Sitting biomechanics part I: review of the literature. Harrison DD, et al, *J Manipulative Physiol Ther.* 1999 Nov-Dec;22(9):594-609.
- Influence of high-heeled shoes on the quadriceps electromyographic activity in women with and without patellofemoral pain syndrome during the sit-to-stand task. L Batistat, et al. *Fisioter Pesq.* 2013; 20(1):2-10.
- “By changing the sitting in an armchair the [intradiscal] pressure can be varied in manifold ways. Under the condition of leaning backwards with about 15° the pressure is decreased to 0.33 MPa. The lower the subject slouched into the chair, the more the pressure decreased (to a minimum of 0.27 MPa), despite further increasing the flexion in his back. Sitting relaxed without backrest in an almost upright position created a pressure of 0.44 MPa as on the stool or on the ergonomic sitting ball. In all these sitting postures the pressure was lower than 0.48 MPa as found for relaxed standing. ***The only exception where the pressure was higher compared to standing with 0.55 MPa occurred when sitting consciously erect***

actively straightening and extending the back, as taught in some back schools.”

- Intradiscal pressure together with anthropometric data - a data set for the validation of models. HJ Wilkea, P Neefb, B Hinzc, H Seidelc, L Claesa. Clinical Biomechanics, Vol 16, Supplement 1, 2001, pp S111-S126.

