Don’t Sit Still: Promoting Back Health While Seated

Research has found that 75 percent of work in industrialized countries is performed while seated (Pynt et al, 2008). Some workers sit for long periods of time while others get out of their chairs at least a couple of times per hour. Either way, it is important for all workers to understand how to keep their back healthy while seated and how appropriate seating and movement can help avoid lower back discomfort and support proper back health.

Researchers have found that 75 percent of work in industrialized countries is performed while seated.[1] In one particular study, Australian workers sat an average of 9.4 hours per day during weekdays, with about half of those hours at work.[2] The study also revealed that people in managerial and professional occupations sat longer at work than technical and blue-collar workers—leading researchers to conclude that people “whose daily work involves long hours of sitting should be the focus of efforts to promote physical activity both within and outside the workplace.”[3]

The effects of seating can be especially detrimental if done for extended periods of time without any posture changes. One study conducted to learn how long people really sit in their office chairs found that all participants got out of the chairs at least a couple times an hour.[4] These results indicate that while computer users are sitting for work, they are not necessarily sitting for long and uninterrupted periods of time. Another study also revealed that just going from sedentary behaviors to getting up and doing light-intensity activities (like walking) for two minutes out of every hour lowered the risk of death for the study participants.[5]

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Sitting will likely remain a posture found in the work environment for many years to come. And some people—for causes not agreed upon by researchers—do experience low back pain when working in a seated posture. So it’s important to know how to keep your back healthy while seated.[6] To alleviate potential issues related to seating, first we need to understand how:

- The back functions
- Sitting impacts the body
- Personal habits can enhance the sitting experience.

One part of the solution for workers in prolonged sitting positions is to provide them with appropriately adjustable seating—a common practice for many organizations. However, new research into individual differences in sitting postures, seating discomfort, and preferred seating support enables task seating design to adjust to accommodate user differences and avoid discomfort. To better understand how to accommodate these differences, we first need to understand how the body works in seated positions, the ways in which postural differences occur in seated positions, and how appropriate seating can avoid lower back discomfort and support proper back health.

It is also important to understand, however, there are advantages to sitting, which Chaffin & Andersson (1984) summarizes as:

1. “provides stability required in those tasks that involve high visual and motor control,
2. is less energy consuming than standing,
3. places less stress on the lower extremity joints, and
4. lowers the hydrostatic pressure on the lower extremity circulation.”[7]

What is a “Healthy” Back?

The Back: A Primer

The human spine is S-shaped when viewed from the side. It is made up of 24 vertebrae and has four curves—from top to bottom: cervical (neck), thoracic (upper back/rib cage), lumbar (lower back), and sacrum connected to the pelvis. (See Figure A.) These curves of the spine are designed for shock absorption, balance, and movement. While the shape of the spine in the cervical and lumbar sections bend forward (lordotic curves), and the thoracic and sacral sections bend backward (thoracic curves), these curvatures are not the same from person to person. In fact, a review of literature revealed large variations in spine curvature amongst individuals. (See Table 1.)

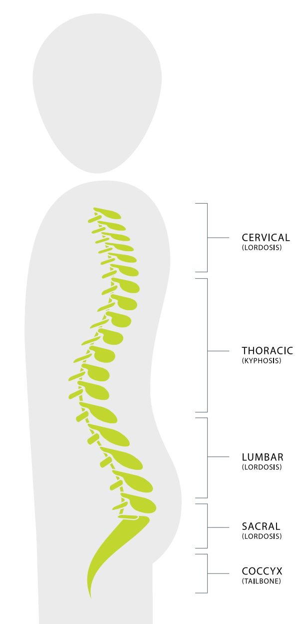

FIGURE A

Range of Spine Angle Measurements	
Cervical Angle[8]	16.5 to 66 degrees
Thoracic Angle[9]	20 to 45/50 degrees
Lumbar Angle[10]	31 to 79 degrees
Sacral Angle[11]	Average 30 degrees

TABLE 1

1 Pynt et al, 2008.
2 Miller and Brown, 2004.
3 Miller and Brown, 2004.
4 Benden et al, 2011.
5 Beddhu et al, 2015.
6 Wilke et al, 1999; Clause et al, 2008.
7 Chaffin and Andersson, 1984.
8 Harrison et al, 1996.
9 Bernhardt and Bridwell, 1989.
10 Wambolt and Spencer, 1987.
11 Nordin and Frankel, 1989.

What are the roles of each section of the back? The cervical vertebrae in the neck allow the most motion in the spine. The thoracic vertebrae are designed for minimal movement and help stabilize the upper back and rib cage while protecting internal organs. The lumbar vertebrae in the lower back provide some motion but are designed to support the weight of the upper body. The sacrum is attached to the pelvis, allowing for little to no motion, which helps strengthen and stabilize the pelvis. Between each vertebra are discs that act as shock absorbers to enable flexibility in the back. Muscles in the torso—specifically the erector spinae—help stabilize the spine and manage the loads on it.[12] The weight of your arms, head, and torso make up two-thirds of your total body weight.[13] So the backrest of a chair needs to be designed to better support and move with that load.

Also important to consider is the orientation of the pelvis. It has a large influence on the shape of the lumbar spine when people stand or sit because the sacrum is fixed to the pelvis. The three different positions the pelvis can be in are neutral, anterior (forward) tilt, and posterior (backward) tilt. (See Figure B.) Its neutral position is the ideal alignment for both the pelvis and low back because it allows for less compression of the spine and more range of motion. This also means that the lumbar curve is just right, which allows for the weight of the torso to be over the center of the body, requiring less effort from the back muscles and reducing loading in the intervertebral ligaments and discs.[14]

Three positions of the pelvis

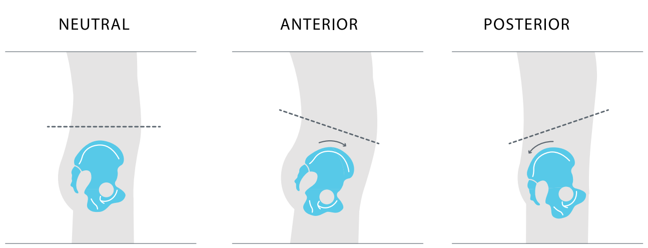

FIGURE B

As the pelvis rotates forward, the curve of the low back is increased, potentially causing an excessive forward curvature in the lumbar spine. As the pelvis rotates backwards, the curvature in the low back straightens and can even take on the shape of the thoracic spine—the opposite of its designed intent. Both positions can put pressure on the intervertebral discs, which can cause low back pain—whether you're standing or sitting. Ultimately, musculoskeletal biomechanics play a crucial role in keeping the torso balanced and upright in both standing and seated positions.

What Happens to the Back When Sitting?

As stated earlier, lumbar curvature depends on pelvic alignment. The pelvis rotates backward when you move from a standing to a sitting posture. This rotation flattens the lumbar curve and could even make it become kyphotic (bowed toward the back). When the lumbar spine is in a kyphotic state, it not only shifts the torso weight forward of its balance point, requiring the back muscles to work harder, but it also unevenly compresses the discs of the lumbar spine.[15] Thus, it is important to ensure that when you do sit, you find a chair that provides good lumbar support and helps maintain the natural curvature of the spine.

In an attempt to understand what truly happens to the spine and the rigid structures it connects with (skull, rib cage, and pelvis), Hubbard, Haas, Boughner, Banole, and Bush built a model to show how each of these interact with the other when a person sits.[16] As a person moves from an upright posture to a reclined posture, the pelvis rotates forward, resulting in a larger lumbar curvature; the bottom of the rib cage rotates forward and the top of the rib cage rotates backward. The model also "…predicts less lumbar curvature when the top of the rib cage is pushed or forced forward," so if a back does not allow the thoracic spine to move backward, then the lumbar spine is effectively flattened.[17] The importance of all of this shows the complexity of the spine and how it is vital to have a backrest with a curvature that accommodates different sizes and shapes of people, and the postural changes they make. In fact, your spine can take on a different curvature every time you recline and/or sit up,[18] so having a backrest that allows for this type of flexibility is an important element for user comfort and support.

It is important to ensure that when you do sit, you find a chair that provides good lumbar support and helps maintain the natural curvature of the spine.

How much the lumbar spine flattens or bows backwards will be different depending on the seated posture and may also be different based on gender.[19] While some studies have shown that there is no difference in the curvature of the spine based on gender, others have shown there are differences.[20,21] The assumption is that gender difference is related to the variations in pelvis size and shape among men and women, which affects the anatomy more when seated than standing. One study revealed that when men sat, their lumbar region of the spine flattened more than women's, which could lead to more disc compression, shorter spinal height, and less lumbar mobility—especially if the lumbar spine takes on a kyphotic curve.[22] Ultimately, this could mean that men might need more lumbar support than women when seated.

12 Biel, 2015.
13 Chaffin and Andersson, 1984.
14 Chaffin and Andersson, 1984.
15 Nordin and Frankel, 1989.
16 Hubbard et al, 1993.
17 Hubbard et al, 1993.
18 Faiks and Reinecke, 1998.
19 Jackson, 1998.
20 Vialle et al, 2005.
21 Endo et al, 2012.
22 Endo et al, 2012.

A variety of studies have shown how a chair affects a person's seated posture. Faiks and Reineke found that the level of support needed by the thoracic spine is much different than the lumbar spine and it is important to consider this when designing backrests.[23] Travell found that the height of the backrest also affected a user's seated posture and that if the back wasn't high enough to provide the needed upper back support that a user would move their buttocks forward and slump in the chair to get the support.[24] While Hubbard et al found how important it was to allow the top of the thoracic spine to move rearward,[25] Bennett, Travell, Diffrient, Andersson et al and Asatekin found that a forward inclination of the upper backrest will push the upper thoracic spine and shoulders forward causing the user to slide into a slumped, kyphotic posture resulting in kyphosis of the lumbar spine and poor pressure distribution over the seat and backrest.[26] Having armrests on a chair that can support the weight of an individual's arm can also decrease thoracic pain because it reduces disc pressure.[27]

Not only is appropriate backrest support in a chair important, but personal work habits while seated also can contribute to back health. Besides lack of proper thoracic support in seating, upper back pain can be caused by poor working habits.[28] When you work in a bent forward posture, the potential for upper back pain is much higher than when sitting upright with the back in contact with the backrest or when reclined on the backrest. Stiffness in the spine can also cause upper back pain, so creating mobility in the spine is important. Because the spine is one continuous unit, when the lumbar moves, movement also occurs in the upper back. This movement helps alleviate stress and—ultimately—upper back pain.[29] One study indicated that users who sit in chairs that allow their spine to change shape (while still maintaining contact with the backrest) experience reduced discomfort in their upper backs.[30] Another way to address upper back pain is for people to sit with the chair in a forward tilt, which brings them forward without the need to round the back and shoulders forward. This posture also puts the pelvis in a position that maintains appropriate curvature in the low back.

Designing Lumbar Support in Seating for Back Health

Knowing our backs best function (i.e., full range of motion and minimal spinal compression) with a lordotic curve, seating design should assist in holding a lordotic curve in the lumbar spine. This maintains disc pressure and back muscle exertion at low levels, particularly when the backrest is reclined from upright.[31] In addition, supporting dynamic lumbar extension postures significantly reduces recovery time of spinal compression, and helps to maintain lumbar range of motion during prolonged sitting—as opposed to sitting with no lumbar support at all.[32]

Additional Design Challenge: Lumbar Asymmetry

In addition to lumbar spinal compression contributing to lower back pain, body asymmetry also has been linked with low back pain.[33] Specifically, the higher the degree of asymmetry in the upper and lower limbs, the greater the likelihood of low back pain.[34] One way to address this challenge of asymmetry is through asymmetrical lumbar support. New research indicates that asymmetrical lumbar support reduces discomfort for prolonged sitting.[35] Seating that addresses proper lumbar support should promote a lordotic curve as well as allow for body asymmetry.

Spine Mobility and Flexibility

Movement is ergonomically beneficial because spinal motion over a period of time changes the loads on the spine, providing spinal nourishment.[36] Loading and unloading the spine allows fluid to be pumped into and out of the discs by osmosis, thus improving the nutritional support to the discs.[37] In one research study, a device that provided continuous passive motion to the lumbar spine during seated postures was utilized to further explore this concept. The results showed the device has the potential to relieve "the effects of static posture during prolonged sitting."[38] Another study revealed that "to provide maximal support, a chair's backrest should follow the motion of the back while the seated individual changes position. The backrest must, therefore, be flexible enough to provide continuous support in both an upright and reclined position. This study demonstrates the need for a backrest that can change its contouring as an individual moves."[39] This does not mean, however, that the backrest needs to be constantly moving when a person is sitting in it.

Besides issues with the spine holding static postures, muscles that hold static postures are constantly working, which can cause them to become tense and create discomfort. Physical therapists will often

23 Faiks and Reineke, 1998.
24 Travell, 1955.
25 Hubbard et al, 1993.
26 Bennett, 1928; Travell, 1955; Diffrient, 1970. Andersson et al, 1974; and Asatekin, 1975.
27 Andersson and Ortgengren, 1974.
28 Vergara and Page, 2002.
29 Hubbard et al, 1993.
30 Amick et al, 2003.
31 Nordin et al, 1989; Chaffin et al, 1984
32 Phimphasak et al, 2015.
33 Friberg, 1983; All-Eisa et al, 2004.
34 All-Eisa et al, 2004.
35 Fredericks et al, 2015.
36 Holm and Nachmeson, 1983.
37 Grandjean, 1980.
38 Reinecke and Hazard, 1994.
39 Faiks and Reineke, 1998.

measure the amount of increased tension in the muscles to determine how much flexibility has been lost due to the build-up of tension in the muscle. In a study conducted to determine how much spinal stiffening occurs during sitting and how long it takes before it occurs, results show differences between the genders: Males lost spinal flexibility more than females did, and their sitting postures changed more than females did during the two-hour sit test.[40] Based on these findings, office workers with task intensive jobs should be provided opportunities to alter their posture.

Providing good back support will also support mental acuity for seated workers and enable them to think more positively.

Ultimately, all of this research shows the importance of avoiding static postures when seated and the benefit of having a backrest that allows for motion and movement in the spine. For proper support and posture, people have different needs. Office workers should be provided with a well-designed chair that adjusts to fit them and encourages them to move and change postures—even when sitting. A person's posture can also impact cognition—showing that sitting habits are not only about the spine.

Sitting Habits

While some postures make people feel comfortable while they are in them, they can lead to ill spinal health over time.[41] Not surprisingly, research supports the notion that a flattened (or kyphotic) lumbar curve and subsequent spinal compression is associated with greater discomfort (leg and back pain) when seated, while a lordotic lumbar curve (and less spinal compression) in the seated position is associated with a significant reduction of back and leg pain.[42] Different working postures have different comfort levels associated with them, depending on the task being completed, so it's important for people to engage in multiple sitting postures when working.[43] Healthy individuals, when properly instructed, can potentially learn to sit in an upright lordotic sitting posture.[44] Also, among people with non-specific chronic low back pain, the ramping up of lower back discomfort during sitting can be reduced by modifying their sitting behavior according to their specific clinical presentation of low back pain.[45] With proper attention paid to individuals' needs, appropriate seating plays an important role in people's back health in the workplace.

Posture and Cognition

As revealed in a number of studies, seated posture can also affect how people think about themselves and perform certain tasks.

- Sitting upright may be the best posture for convergent thinking, and being able to move about and change postures frequently helps with divergent thinking.[46]
- When sitting, participants scored higher on the Complex Assessment test ($p = 0.009$), suggesting that people may want to sit when they are working on a complex tasks and need to make decisions.[47]
- Sitting reclined and relaxed allows people to broaden their categorical thinking, resulting in their being more open to new opportunities.[48]
- Sitting relaxed makes people feel less stressed or anxious than when sitting in a tense posture.[49]
- Sitting in a slumped posture negatively impacts a person's perseverance to problem solving, compared to sitting upright.[50]

Providing good back support will also support mental acuity for seated workers and enable them to think more positively.

Summary

When prolonged sitting cannot be avoided, seating should promote back health through proper, customized support—meeting each person's changing postural needs. Lumbar support should help maintain a lordotic curve, thus reducing spinal compression and maintaining range of motion, while thoracic support should allow for a backward motion of the upper thoracic spine. Both of these needs emphasize the importance of having a backrest that is designed to fit the curvature of the spine while providing the ability for people to move while sitting. A backrest should also accommodate back asymmetry to avoid additional discomfort. These seating features, in combination with other back health interventions—such as changing postures, getting up and walking, and engaging in light activity for at least two minutes every hour—play an important role in healthy workplaces.

40 Beach et al, 2005.
41 Pynt et al., 2008. 42 Williams et al, 1991; Phimphasak et al, 2015.
42 Williams et al, 1991; Phimphasak et al, 2015.
43 Workineh and Yamaura, 2015.
44 Korakakis et al, 2014.
45 O'Sullivan et al, 2013.
46 Schulman and Shontz, 1971.
47 Andersen, 2010.
48 Harmon-Jones, et al, 2012.
49 Riskind and Gotay, 1982.
50 Brinol, et al, 2009.

Contributors

Teresa Bellingar holds a Ph.D. in Industrial Engineering specializing in Occupational Safety and Ergonomics, and is a Certified Professional Ergonomist. As Haworth's Senior Corporate Ergonomist, she is responsible for ensuring ergonomics and ADA are incorporated into product design, managing ergonomic research, and representing Haworth on North American ergonomic standard/guideline committees and BIFMA seating standard committees.

Beck Johnson holds a B.S. in Scientific and Technical Communication and an M.A. in Communication. With 15+ years of experience in social science research methodologies and as a Research Specialist at Haworth she conducts primary and secondary research addressing workplace issues.

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