Kate Nagel
Advanced Orthopedics Paper: Postural Dysfunction
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In the United States, one in four adults spend around 70% of their time sitting.[1] According to an article by Owen et al, there has been a shift from a lifestyle that is "physically demanding" to one that requires little physical challenge.[1] In 2003, almost six out of 10 adult utilized a computer at their place of work, while greater than nine out of 10 children utilized computers at school.[1] Additionally, "screen time" has drastically increased, with people watching an estimated four hours of television daily.[1] This sedentary behavior not only effects systemic health, including the risk of cardiovascular disease, diabetes, and cancer, but it can also affect posture and the musculoskeletal system.[1,2,3] An article by *The Washington Post* deemed sitting as a "health hazard", citing neck, shoulder, and upper/lower back pain or problems as side effects.[3]

The *American Physical Therapy Association's Guide to Physical Therapist Practice* defines posture as "the alignment and position of the body in relation to gravity, center of mass, or base of support".[4] "Optimal posture" is a when there is good skeletal alignment and musculoskeletal balance that protects against deformity or injury.[4] Unfortunately many people make their way into a physical therapy clinic with complaints of neck, jaw, shoulder, or lower back pain, potentially as a result of their current sitting postures and "screen time" habits throughout the day. By understanding the influence of sitting and the use of electronics on the tissues that influence posture (bone, muscle, tendon), physical therapists can work towards creating the structural and muscular balances through their interventions.

The human skeletal system is used, among other things, for structural support of the body, to offer "rigid kinematic links"[6] and attachment sides for muscles, which further provides levers that manipulate the direction and magnitude of muscle forces.[5,6] Muscles help maintain body position and posture, while supporting soft tissues.[5] Tendons adhere the muscles to bone, and serves to transfer large muscle forces to the bones for movement.[5,7] When the body

maintains correct posture, it aids the bones and joints to maintain a correct alignment that will in turn let muscles be used effectively.[8] This decreases the (sometimes abnormal) wear and tear of the joints.[8]

The human head's weight encompasses 1/7 of a person's body weight.[9] When the head is leaning forward for long periods of time (example: looking at a cell phone or computer screen), it applies 3.6 times more force than what is necessary to maintain the head in a correct standing posture.[9] The weight of the head is increased with forward head posture since it deviates from the midline of the body.[9] This affects the cervical vertebrae since the upper vertebrae will be extended while the bottom vertebrae will be flexed.[9] Furthermore, the cervical joints and musculature have pressure applied due to the "bending moment of the head".[9] When forward head posture occurs, the body compensates by causing the atlanto-occipital joint and upper cervical vertebrae to increase in extension, creating a protrusion of the upper cervical vertebrae and directing the face upwards.[9]

Additionally, the "line of gravity" is pushed anteriorly with forward head posture, causing and increased flexion moment.[10] This causes the cervical extensor muscles to become "ischemic" since they are in a constant isometric contraction to offset the greater than usual external flexion moment to maintain the head in a forward position.[10] The temporomandibular joint, or TMJ, structure might also be distorted with forward head posture, affecting the joint's function.[10] In particular, the superhyoid muscles are stretched, which causes the mandible to be positioned "posteriorly into retrusion".[10]

Since the neck bones' curvature has changed, it causes an "upper-crossed syndrome" with muscle imbalances, eventually leading to rounded shoulders.[9] Rounded shoulders are a result of the "protrusion of the acromion of the shoulder joint relative to the centerline of gravity of the

body, causing stooped posture along with elevation, protraction, and downward rotation of the scapula, and an increased angle between the lower neck bone and upper spine".[9]

When seated for prolonged periods of time, the lumbar spine is flexed which can cause increased "intradiscal pressures, and induce viscoelastic creep in passive elements".[11] 40% more intradiscal pressure is present at L3 in "unsupported slumped sitting" compared with erect standing.[12] This increases to 85% if the patient leans forward while in a seated, slumped posture.[12] When patients are seated in a slumped position for long periods of time, the "postural stabilizing muscles" activity is reduced.[13] This causes those postural muscles to become deconditioned with decreased efficiency, causing more stress on the lumbar ligaments and discs.[13] This can lead to instability, strain, or other injury of the lumbopelvic region.[13]

While neck and lower back pain are common pathologies related to poor posture, patients may also complain of headaches, jaw pain, and shoulder pain. Neck "musculoskeletal impairments" can be a source of "nocicpetion" in patients who complain of migraine headaches, potentially due to "postural imbalances" of the neck/head region.[14] When postural adaptations have increased or decreased inputs from one of the "multisensory afferent inputs (visual, vestibular, and somatosensory systems)", it can cause a "postural misalignment" which can lead to muscle imbalances.[14] A study by Ferracini et al found that participants with migraines demonstrated "active and latent" trigger points in their neck and head muscles.[14]

"Tension-type" or cervical headaches might also be common in this patient population, and is caused by muscle tension of the suboccipital muscles.[9,15] Symptoms normally start at the posterior aspect of the head and radiates to the anterior/superior aspect of the head and the eyes.[15] Patients may describe the sensation like there is a tightness or that they are "wearing a

tight cap".[15] Certain position, like sitting at a desk, may make the symptoms worse, while other positions may ease the pain.[15]

Patients who complain of cervical or tension headaches may also experience pain along their jaw line, or "temporomandibular joint dysfunction" (TMD).[15,16] When sitting at a desk or driving in a car for long amount of time, many people move into a forward head posture, causing stress on the TMJ's ligaments, disk, and muscles.[16] This, in turn, causes the jaw to "rest" in an "open position", overusing the muscles of mastication.[16] The main symptom of TMD is jaw pain, but "jaw fatigue", dizziness, headache, difficulty opening the mouth to talk or eat, or "popping" jaw sounds are also symptoms.[16]

Shoulder pain is another potential complaint of patients who live sedentary lifestyles and have postural dysfunction. While they might have forward head that had progressed into rounded shoulders[9], shoulder pain can also be caused by repetitive, small movements like moving a computer mouse.[17] These repetitive, yet smaller movements can stress the upper extremity muscles and tendons.[17] Work environments tend to be a cause of shoulder pain, whether it is "working in awkward postures" or "high psychosocial job demand(s)" that prevents the ability of the patients to relax.[18] Shoulder impingement is a specific shoulder injury or conditions related to poor posture.[19,20] Shoulder impingement is defined as "compression and mechanical abrasion of the rotator cuff structures as they pass beneath the coracoacromial arch during elevation of the arm".[20] This constant compression causes range of motion difficulties along with pain.[20,21]

While many of the risk factors related to poor posture might seem obvious, many patients might not know why they have constant pain in their neck, lower back, jaw, or shoulder. Individual factors related to poor posture can include gender, age, body mass index (BMI), smoking, and exercise habits (or lack thereof).[22,23] The duration of sitting in a poor posture can

also be related to the risk for injury.[22] According to a study by Spyropoulos et al, participants that exhibited a forward bent position for greater than two hours each day had a higher prevalence of lifetime lower back pain.[22] "Work related risk factors"[23] like sitting duration, design of the workplace, and unchanging arm and neck postures are also positively correlated with various neck pathologies and also relate to shoulder pain.[17,18,23] According to a study by Cagnie et al, participants holding their necks in a forward head posture for an extended period of time was related to neck pain.[24] Psychological and/or psychosocial work environments also play a role in postural related pain.[18,22,23] Stress, job demands, job satisfaction, and depression all relate to shoulder, neck, and lower back pain.[18,22,23]

The utilization of ergonomics office equipment can greatly influence the prevalence of neck pain.[23] A study by Korhonen et al found that the lack of computer ergonomics equipment was a predictor of neck pain.[23] One particular ergonomics aspect that might be important for this patient population is the distance the patient is from their computer.[22] Spyropoulos et al found that when the participant's body was 50-100cm from the computer screen, they appeared to have a greater prevalence of back pain.[22] While the computer distance might be an indirect effect of their back pain, it caused the participants to make adjustments to their postures, straining the lumbar spine and creating pain.[22]

While physical therapists cannot control many of the individual risk factors of postural related pain, like age and gender[22,23], they can help this population improve their posture and decrease their pain. Intervention plans of care for this patient population should include patient education on ergonomics options for their office and home, along with exercises that will provide neuromuscular re-education and strength to the postural muscles and manual therapy techniques.

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Patient education is an important part of a physical therapist's plan of care. While physical therapists can offer exercises that will help patients' injury or condition, if the patient's work and home environment are not corrected with proper standing and sitting ergonomics, it will be difficult for their condition to improve. According to the *American Chiropractic Association*, in order to sit properly, feet should be kept flat on the floor with the legs uncrossed.[8] Ankles should be in front of the knees with a small space in between the knees and front of the seat.[8] Knees should be below or at the same level as the hips, and the lower back should be supported with a backrest.[8] Shoulder should be relaxed with forearms parallel to the ground.[8] This information will be helpful for patients who spend most of their time in the seated position.

The *Mayo Clinic* has additional information that would act as a great handout for patients who are office workers (See the image in Appendix A).[25] In addition to an adequate, supportive chair and properly positioned keyboard and mouse, *Mayo Clinic* also suggests keeping items like the stapler or phone close to the person to decrease the amount of reaching.[25] If the items are not within a comfortable reach, it's best to stand up to obtain the item instead of reaching uncomfortably from a seated position.[25] Feet should be rested on the floor or on a footrest, and the desk should be positioned in a way to clear the thighs, knees, and feet.[25] The computer monitor should be directly in front of the person at around an arm's length away.[25] The top of the computer screen should be a little below or at eye level and the monitor should be placed directly behind the keyboard.[25]

While this patient population might (unfortunately) spend most of their time at work, educating patients on proper standing posture will also help correct and maintain good posture will decreasing their pain. To stand properly, the weight should be maintained on the "balls" of the feet.[8] Knees should be slightly bent and feet kept shoulder-width apart.[8] Arms should be

relaxed and shoulders "pulled backwards".[8] Earlobes should be in line with the shoulders, avoiding forward head posture.[8]

Additionally, physical therapists should ask their patients about their sleeping posture. Obtaining an adequate mattress is important, and specialty pillow choices can also assist with postural dysfunction.[8] Side sleeping is usually the most helpful for back pain, and if patients choose this sleeping position, suggest placing a pillow in between their legs.[8] If the patients choose to sleep on their backs, placing a pillow under their knees might be helpful.[8] If at all possible, have patients stay away from sleeping on their stomachs.[8]

Besides patient education on ergonomics, physical therapy interventions for the treatment of painful pathologies related to poor posture include muscular strengthening exercises and manual therapy techniques. For jaw pain and related TMD, therapeutic exercises are often used to deal with specific TMJ impairments while improving TMJ function.[26] Exercises for TMD are intended to enhance the coordination of muscles, relax muscle tension, and improve muscle strength and range of motion.[26] To re-educate the TMJ musculature, muscle strengthening and stretching exercises should be utilized along with manual therapy.[26] Active and passive range of motion are also helpful to decrease pain and "increase oral opening".[26] Postural exercises are also important to repair or "optimize" the "craniomandibular" system's alignment.[26]

For patients with shoulder impingement, potentially resulting from postural dysfunction, a study by Bang and Deyle suggest that a treatment plan should include both manual therapy and supervised therapeutic exercises, as opposed to just exercises.[27] The therapeutic exercises should include passive and active range of motion, and six strengthening exercises (four of which utilize "Theratubing").[27] Strengthening exercises to incorporate into an exercise program for this

pathology includes rows, shoulder scaption, shoulder flexion, "horizontal extension-external rotation", seated press-up, and "elbow push-up plus".[27] The first four exercises would utilize the "Theratubing".[27]

Neck pain, another pathology related to poor posture, can also be addressed with therapeutic exercises. An article by Im et al found that scapular stabilization exercises improved forward head posture and neck pain, and even assisted with participants' quality of life.[28] These exercises worked to re-educate and correct movement patterns of trapezius and serratus anterior muscles, as they provide an essential piece of shoulder and neck disorder rehabilitation.[28] In particular, the exercises hope to decrease the activation of the upper trapezius muscle, while facilitating the lower trapezius and serratus anterior to maintain good postural control.[28] By organizing the training in this manner, the study showed that the upper trapezius and serratus anterior muscles had more control, which brought "the scapular and thoracoscapular positions closer to normal from forward head posture".[28] Other scapular stabilization exercises that could be helpful include "scapular-clock" exercises, T's and Y's on a swiss ball, and scapular protraction.[20]

Besides therapeutic exercises, Lee et al found that Pilates can be a useful treatment intervention for patients with forward head posture.[29] While many exercise interventions might focus on strengthening the deep neck flexors to attain the cervical spine alignment, those exercises alone might not address why the misalignment developed in the first place (and only address the symptoms).[29] Pilates training is a good intervention for this patient population because it promotes an improvement in universal body health and flexibility by stressing posture, core strength, and "coordination of breathing with movement".[29] It provides postural improvement by increasing body awareness to treat the postural misalignments specifically.[29]

Pilates is a great intervention because it focuses on "improving systematic balance rather than specific (cervical or thoracic) regions, which emphasizes core stability and spinal separation".[29]

Additionally, Pilates works towards decreasing muscle tension in weak and shortened muscles during exercise, improve participants' breathing methods and therefore core stability, and increase participants' awareness of their "postural misalignments".[29] Despite this study demonstrating the usefulness of Pilates, the authors also state that "pain is associated with altered muscle recruitment patterns: thus, it might be useful to include exercises that can retrain muscle recruitment patterns, especially ones that focus on the theory of stabilizing locally before moving globally".[29] This statement might point back to the use of scapular stabilization along with Pilates techniques to help this patient population.[20,28,29] Additionally, if neck pain and postural dysfunction are improved, it may help patients that also suffer from headaches.[14]

While Pilates can help patients with forward head posture since it concentrates on core strength, Pilates might also be a helpful intervention for patients who have lower back pain related to poor posture.[29] Therapeutic exercises like bridging, planks and side-lying hip abduction can also be helpful in decreasing lower back pain and correcting poor posture like slumping in a chair.[30] Since sitting decreases the lumbosacral curvature angle and causes more of a posterior pelvic tilt, sitting for longer periods of time can create musculoskeletal complaints, along with added disc pressure.[11,12,31] To correct poor posture, a study by Barczyk-Pawelec et al found that when participants actively corrected their posture with the cue "straighten your back", it activated "lumbo-pelvic stabilizing musculature" to maintain an "optimally aligned erect posture".[31] The authors also suggest that neuromuscular control is crucial for the protection of spinal motion segments from collapsing during shear, bending, or axial rotation focuses.[31]

Consequently, educating patients to develop the skills required to enhance "self-corrective spinal posture" in an extended sitting or standing position may be essential to a healthy lifestyle.[31]

While it may be difficult to prevent these pathologies, attempts can be made by starting with ergonomics and posture education for patients that do not present with any postural dysfunction symptoms, but may state that they are an office worker or lead a sedentary lifestyle. Additionally, providing consulting services to various businesses to educate them on proper office ergonomics to avoid neck, jaw, shoulder, or back pain could be helpful. Ergonomic suggestions can include evenly distributing body weight in standing and alternating sitting positions to forward on the chair and back against the chair throughout the day.[32] Advising this patient population about not only appropriate ergonomics equipment, but also about incorporating active rest breaks will also prevent poor posture and related pain.[32] recommending appropriate footwear, along with potential ergonomic modifications outside the office (like home or car), will also help maintain proper posture and avoid pain.[32] Finally, suggesting preventative therapeutic exercises that will be incorporated into their current exercise route might also help prevent poor posture due to sitting at a computer for long periods of time.[32,33] Exercises like chin tucks, upper trapezius stretch, scapular squeezes and rolls, and stretching of the pectoral muscles can potentially help prevent poor posture of starting in the first place.[33]

With the increase of sedentary behavior, the prevalence of pathologies related to poor posture, whether it is headaches or jaw, neck, shoulder, or back pain, will become a more common occurrence in physical therapy clinics. While physical therapists might find it difficult to prevent these injuries or conditions, patients can be provided with adequate ergonomics education along with appropriate therapeutic exercises to improve flexibility and re-education/strength of postural muscles while decreasing pain. Risk factors of postural

dysfunction can be individual, related to work environment or poor ergonomics equipment, or be psychological/psychosocial in nature. Physical therapists can work with this patient population to determine the sources of their pain, while providing neuromuscular re-education to their postural muscles to maintain proper posture as they sit and stare at their computer screen and electronics.

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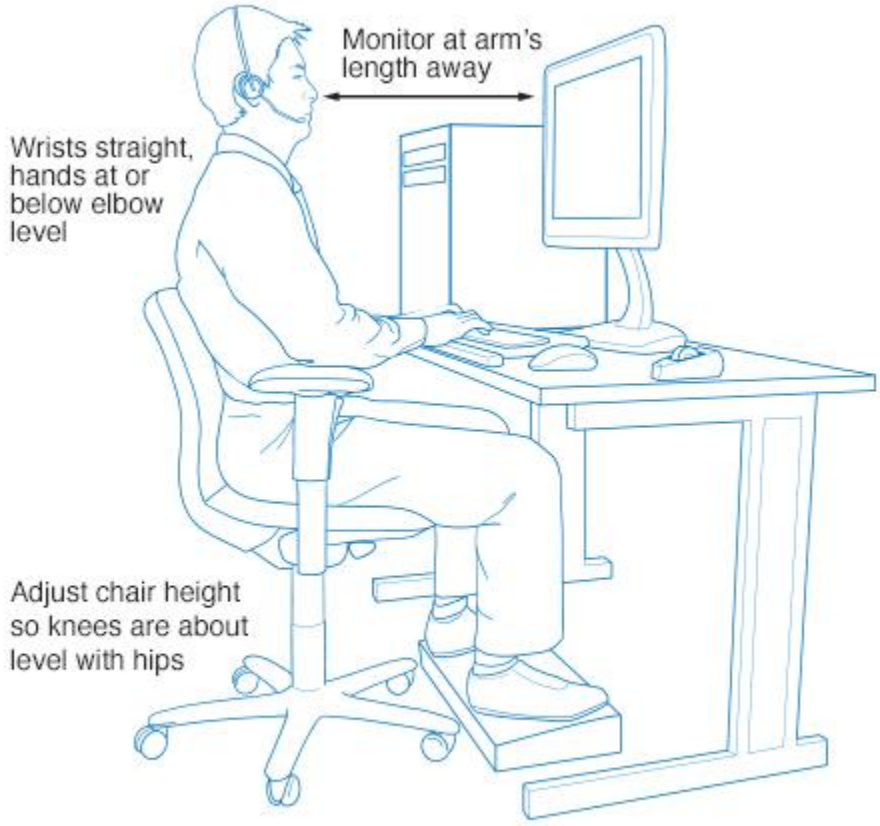
Appendix A: Potential Patient Education Materials



Picture Reference: Office ergonomics: Your how-to guide. Mayo Clinic website. http://www.mayoclinic.org/healthy-lifestyle/adult-health/in-depth/office-ergonomics/art-20046169. Published April 20, 2016. Accessed December 3, 2016.