Furniture prescription for the conservative management of low-back pain

by Eileen Vollowitz, BS, PT

Many people with low-back pain find little relief from the traditional medical advice: "Sleep on a firm mattress," or "Sit with a lumbar support." For some, following this advice may even contribute to exacerbation of the low-back problem. When the same form of care helps some, hurts some, and makes no difference to others, it is likely that similar clusters of symptoms and signs exist within each group that could guide health care personnel in predicting these outcomes. While it is generally accepted that specifically prescribed and well-fitted furniture plays an important role in the conservative management of low back pain, there is no published information correlating specific furniture design characteristics with various presentations of low-back injuries.

People with low-back disorders present with special sensitivities to position, weight bearing, and constrained postures and pressure, for which furniture must compensate. Furniture design guidelines based on body measurements and physical demands analysis rarely consider these special needs. A furniture prescription should match specific furniture design characteristics with the physical demands of an activity, an individual's structural characteristics, and the functional loss characteristics of a particular low-back injury.

Traditional methods of patient evaluation directed toward diagnosis and work capacity assessment do not thoroughly address these special areas of functional loss. This article presents a method for identifying specific functional loss characteristics in people with low-back disorders and methods for using this information for furniture prescription. For the sake of brevity, discussion is limited to prescriptions for seating and mattresses.

FUNCTIONAL LOSS CHARACTERISTICS

Key areas of functional loss are classified according to four common patterns of symptom behavior: sensitivity to position, to weight bearing, to constrained postures, and to pressure. The success of the furniture prescription depends on a timely match of each furniture design characteristic to each person's unique presentation of functional loss.

Topics in Acute Care and Trauma Rehabilitation 1988:2(4):18-37

Position sensitivity

Position-sensitive conditions are consistently aggravated by specific postures or positions, and are relieved by other postures or positions. Physical examination often reveals asymmetry in the quality or quantity of lumbar motion which correlates with the reproduction of the symptoms. The aggravating and easing positions vary among different types and stages of low-back injury, among different individuals, and among various activities. In most cases the least symptomatic lumbar position is in some degree of lordosis, near the mid-range of all available lumbar movements.

The mid-range lumbar position may be relatively flat in one person and very lordotic in another. The important point is that whether flat or lordotic, this position is mid-range-of-motion for that individual.

A position-sensitive person will use thigh positioning to control lumbar position. The pelvifemoral relationship is such that for every three or four degrees of femoral motion, there is one degree of pelvic motion.[1] Thus, a mid-range lumbar curvature is passively produced in most relaxed individuals by positioning the thigh and torso at a 135-degree angle.[2] Lumbar electromyographic and intradiscal pressure studies indicate that the spine may be most relaxed at similar thigh-torso angles.[3,4] This thigh-torso position is frequently observed as a position of comfort in the position-sensitive individual (see Figure 1).

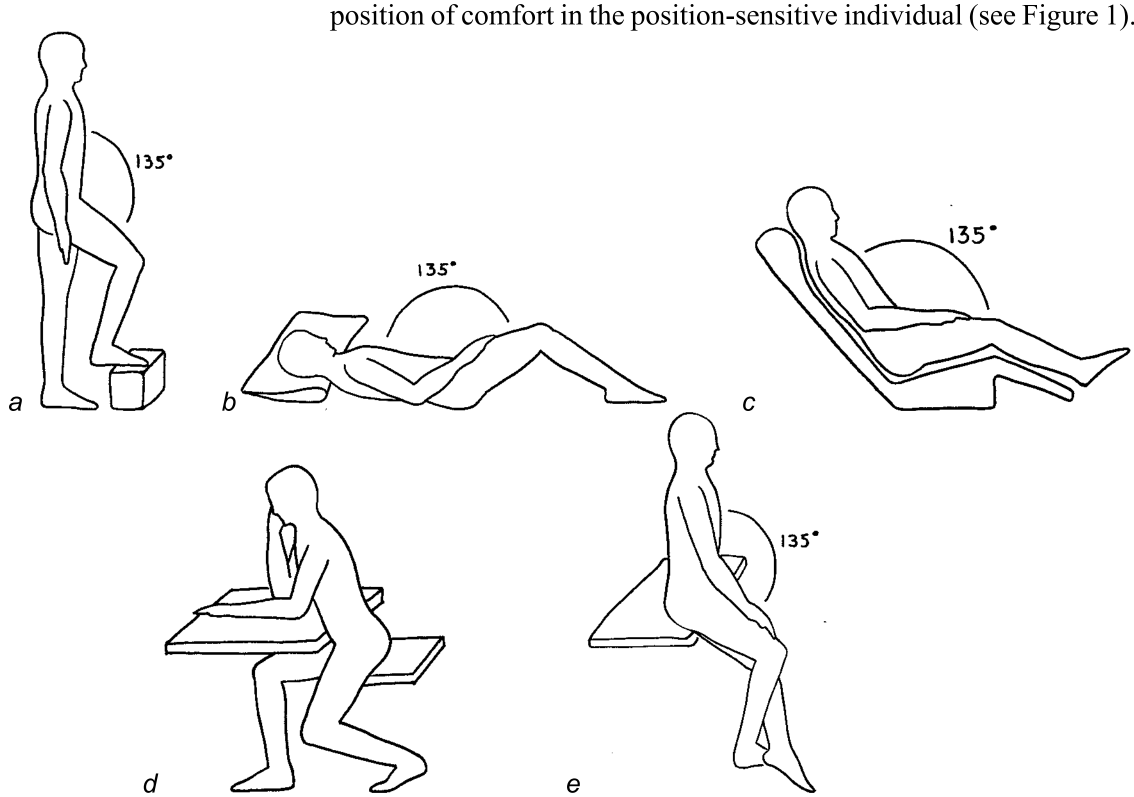


Figure 1
Passive positioning behaviors frequently observed in the position-sensitive individual. Mid-range-of-motion lumbar positioning is preserved by maintenance of a constant thigh-torso angle.

Lumbar pathology may bias the position of comfort away from the mid-range. Common positional biases occur in flexion and extension.

Individuals with a flexion bias find comfort on the flexed side of their mid-range lumbar position.[5] They display passive positioning behaviors with more acute thigh-torso angles (eg, preference for sitting on low chairs with knees higher than hips, for sitting instead of standing, or for sleeping in a fetal position). Individuals with diagnoses of spondylolisthesis, spinal stenosis, and "facet syndrome," are reported to have flexion biases.

Individuals with an extension bias find comfort on the extended side of their mid-range lumbar position.[5] They display passive positioning behaviors with less acute thigh-torso angles (e.g., preference for sitting on high stools with knees lower than hips, for standing instead of sitting, or for sleeping supine or prone). Individuals with diagnoses of mild posterolateral disk involvement are reported to have extension biases.

Well-coordinated and properly trained, position-sensitive people stay symptom free with careful control of lumbar posture during work and leisure activities. With control of spinal position they can sit, sleep, lift heavy objects, and sustain weight-bearing postures without symptoms.

For position-sensitive conditions, prescribed furniture must control spinal positioning.

Weight-bearing sensitivity

The importance of vertical loading as a risk factor in low-back pain is well recognized. Studies also suggest that low-back pain occurs at an earlier age in subjects exposed to vibration.[6,7] However, it is not well recognized that weight-bearing sensitivity may be the primary functional loss in certain people.

Weight-bearing-sensitive conditions are consistently aggravated by gravity and compression forces, as when standing, walking, running, sitting, coughing, and during strong muscle contraction. They are relieved by reduction of loading, as when lying down, floating in water, being in traction, and wearing an elastic abdominal binder. They often have increased sensitivity to vibration, as when riding in a motor vehicle or operating heavy equipment.

Common postural behaviors observed in weight-bearing-sensitive people include a number of load-relief maneuvers, such as leaning against walls and furniture and heavy reliance on armrests in chairs (see Figure 2). Weight-bearing-sensitive people change position very often during load-bearing activities (the "squirm factor"[8]), presumably to shift loads. Unlike the position-sensitive person, they frequently shift from one end-range lumbar position to another, and find little relief in any position. They can sustain postures for prolonged periods of time when non-load-bearing, as evidenced by their ability to lie in comfort in reclining chairs or in bed for extended periods.

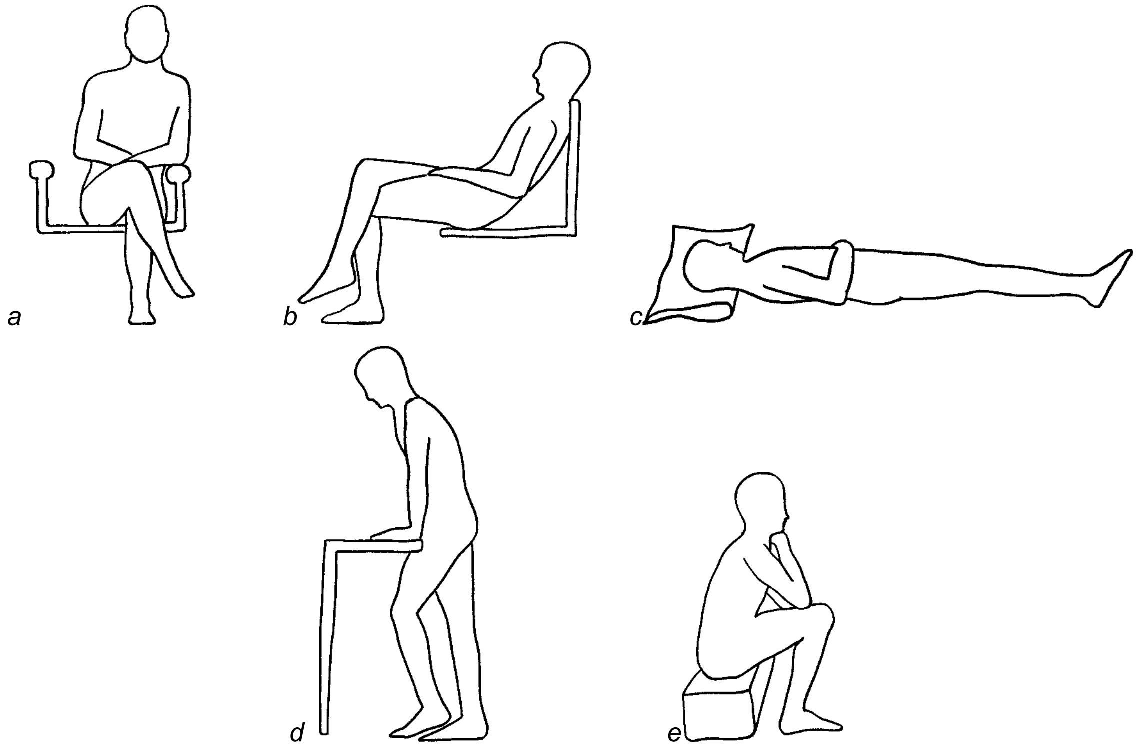


Figure 2
Weight-bearing-sensitive individuals seek frequent relief from gravity loading by supporting their torsos through their arms, against walls and furniture, and by recumbency.

Weight-bearing sensitivity is easily overlooked during the clinical examination. Identification is based primarily on the history and observation over a period of time. Only subtle objective findings are apparent on physical examination, for example, abnormally soft end-feel findings with manual passive intervertebral movement testing. Active range of lumbar motion may be full and symmetrical, with no clear correlation between movement, position, and the reproduction of symptoms.

Physical management with emphasis on posture and proper lifting techniques is rarely effective for the weight-bearing-sensitive person. In fact, the weight-bearing-sensitive person is often worsened by participation in these programs, presumably due to the prolonged periods of compressive loading common during sitting activities, postural training, and lifting training sessions.

For people sensitive to weight bearing, prescribed furniture should minimize passive vertical loading and allow frequent shifting of loads.

Weight-bearing tolerances are improved, sometimes dramatically, with conversion to "active-sitting" postures which recruit the large postural muscles of the trunk and lower limbs (e.g., sit-stand or saddle-sitting postures) versus "passive-sitting" postures in which in the postural muscles are dormant (e.g., conventional "ergonomic" seating).

Constrained-posture sensitivity

Healthy people change body postures every 5 to 15 minutes during the day and night. When these normal body movements are constrained, health problems occur. Postural fatigue and sickness absences increase when postural changes are limited on a job.[9,10] People sensitive to constrained postures must change positions even more frequently.

Conditions sensitive to constrained postures are aggravated by prolonged static positioning and are eased by frequent position changes. There is no consistent position or posture of relief or aggravation, nor is there a consistent easing of symptoms with weight-bearing relief. There are increased symptoms during the night, in the morning upon awakening, during driving and other constrained sitting activities, and with standing. These people feel better when moving, and can often walk, run, participate in sports, and perform varied dynamic and heavy work tasks without incurring symptoms.

As with weight-bearing sensitivities, sensitivity to constrained postures is easily missed during the clinical examination.

People with constrained-posture sensitivity may worsen if they follow the advice of the well-meaning clinician who tells them to sleep supine with a pillow under their knees all night, or to sit using a lumbar roll with no variation in lumbar postures.

As with weight-bearing sensitivities, sensitivity to constrained postures is also easily missed during the clinical examination. Identification of the syndrome is based on the history and observation over a period of time, while the physical examination reveals only subtle findings, for example, abnormally boggy end-feel findings with manual passive intervertebral movement testing. Lumbar range of motion may be full and symmetrical, and in some cases may be hypermobile.

The goal of the furniture prescription for people sensitive to constrained postures is to superimpose constant motion on the activity without interfering with function.

Pressure sensitivity

Pressure-sensitive conditions are aggravated by direct pressure and are eased with relief from direct pressure. The nature of the functional loss will vary with the location of the sensitive tissues. People with pressure sensitivity over the posterior spinous processes are unable to use a hard-backed chair or a lumbar roll. People with sensitivity over the ischial tuberosities are unable to sit on firm seats. Those with pressure sensitivity over the greater trochanter or sacrum are often unable to sleep on a firm mattress.

Pressure sensitivity can occur in the absence of position, weight-bearing, and constrained-posture sensitivity.

Furniture prescribed for pressure-sensitive conditions should dissipate pressures over the sensitive areas. If the pressure sensitivity is a referred rather than a local-tissue phenomenon, it may be possible to control it by mediating its associated positional, weight-bearing,and constrained-postural factors.

COMMON PRESENTATIONS OF FUNCTIONAL LOSS

People usually present with elements of more than one type of functional loss in varying degrees of severity, and the type and severity of functional loss may change with time.

The type of functional loss may change as the stage of the pathology changes. For instance, immediately following an acute low-back injury, weight-bearing and constrained-posture sensitivity may predominate. As the condition heals, weight-bearing and constrained-posture sensitivity may decrease and a clear position sensitivity may remain. This progression is commonly observed. It is less common to see a prolonged course of primary weight-bearing or constrained-posture sensitivity, although this does occur in chronic conditions.

There may be more than one focus for a symptom complex, each with a different type of functional loss. For instance, an individual may present with central lumbar pain, which is clearly position sensitive; sciatica, which is primarily weight-bearing sensitive; and hip pain, which is pressure sensitive.

Functional loss characteristics can be rated according to the degree of functional loss and the severity and irritability of symptoms produced.[11] These ratings become part of the baseline against which the efficacy of a successful prescription is measured, and guide the prescribing practitioner in setting priorities for the furniture design prescription.

These functional loss classifications have been clinically observed, but have not yet been correlated with specific diagnostic entities.

PHYSICAL-DEMANDS ANALYSIS

An activity for which furniture is required should be analyzed according to the positional, weight-bearing, constrained-posture and pressure demands it places on the lumbar spine and its associated structures. Physical demands will vary among various activities, and from moment to moment as an activity progresses. The physical demands of any particular activity is also altered by each person's unique habitual movement behavior, body size, and structure.

Physical demands of sitting

Sitting activities are classified into three general types according to the position of the body's center of mass: forward, erect, and posterior sitting (see Figure 3).[7] The forward-sitting posture is observed during two-handed manipulative tasks such as drafting, drawing, dentistry, and small equipment repair, and for forward reaching tasks such as writing and paper handling. The erect-sitting posture is often assumed for typing and interactive computer work. The posterior-sitting posture is observed during computer inquiry use, conferencing, telephone activities, television viewing, and driving.

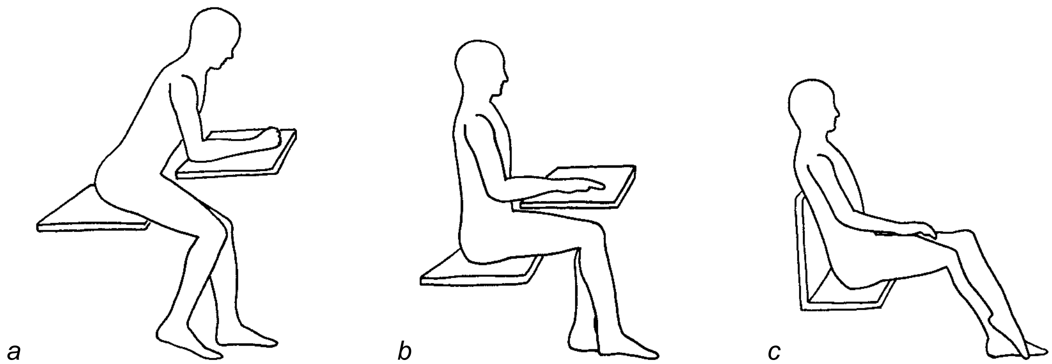


Figure 3
Sitting postures are classified according to the position of the body's center of mass: (a) forward sitting, (b) erect sitting, (c) posterior sitting.

The location of a visual target or hand-task largely determines sitting posture because it affects the orientation of the eyes and head. This in turn determines neck and trunk position and affects positioning of other body parts (see Figure 4).[12,13] It is therefore possible to control sitting posture by careful positioning of viewing materials and task materials. Near-sightedness, poor lighting, and glare can contribute to postural compromise in the low back.

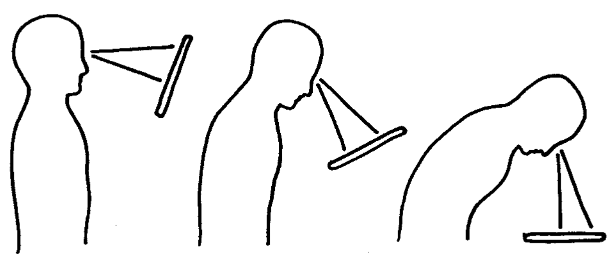


Figure 4
The requirements of vision will cause the body to change its orientation so that the face is nearly parallel with the viewing surface.

The physical demands of sitting will change depending on the nature of the sitting task, the design of the furniture used, and the physical characteristics of the person sitting.

Sitting is a weight-bearing activity. Weight bearing is usually least in posterior sitting and greatest in forward sitting, since the backrest on a traditional chair cannot be used in forward postures. If the task and work-surface height allow users to lean on their arms, if the chair has a front support for the torso or pelvis, or if the feet are positioned directly beneath the body's center of mass (as with saddle-sitting), weight bearing during forward sitting postures is greatly reduced. Weight bearing is further reduced in erect and posterior seated tasks with larger backrests and well-fitted armrests.[4]

The greater the thigh-torso angle, the greater the lumbar lordosis. The less the thigh-torso angle, the less the lordosis. Thigh-torso angle is affected by seat-back angle, seat height, and the location of the visual target or task.

Reclined backrests tend to increase thigh-torso angle and so increase lumbar lordosis. Sitting in a traditional chair with an erect backrest decreases thigh-torso angle and tends to decrease lumbar lordosis. For most people, lumbar positioning is significantly compromised during forward-sitting activities.

Those with forward-sitting tasks generally prefer higher seats than those with posterior-sitting tasks.[14] As seat height is raised both the thigh-torso angle and the degree of lumbar lordosis are increased. Conventional ergonomic seating accommodates the increased seat height with a forward seat tilt. The forward seat tilt feature, however, has limitations in conventional ergonomic seating. There is a tendency to slide off a forward-sloped seat if it is tilted more than a few degrees. Tractor-seat contours reduce this shearing effect somewhat, however it is not possible to achieve a full 135-degrees thigh-torso angle in conventional ergonomic task seating.

For erect and forward activities the semi-sitting (e.g., saddle-sitting) posture, an intermediate posture between standing and sitting, is ideal. In saddle-sitting, a higher than normal chair is used, usually with a straddle, hip-abduction posture, which allows the person to divide their body weight between their buttocks and feet.[15] The participation of the feet activates the postural muscles, while the hip-abduction posture stabilizes the pelvis in an upright orientation (see Figure 4). An added bonus is that saddle-sitting also preserves spinal postures when bending forward to work.

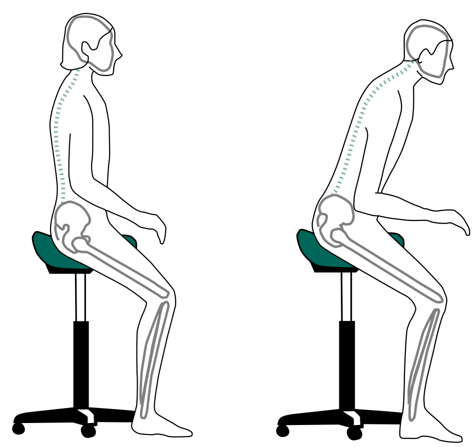


Figure 5
Saddle-sitting permits the spine to retain its natural curves, even when leaning forward to work.
(reproduced with permission of Bambach Saddle Seat Pty. Ltd.)

A low seat height decreases the thigh-torso angle and flattens the lumbar spine. Thus the common medical advice to sit with the knees higher than the hips may be advisable for posterior sitting and erect sitting, but is just plain bad advice for people working in forward-sitting postures (see Figure 6).

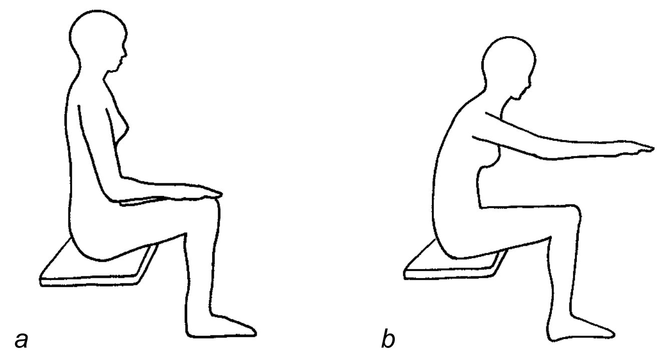
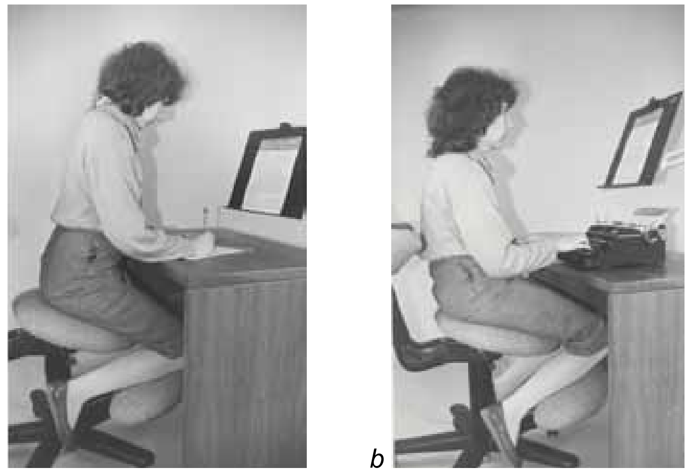


Figure 6
(a) Sitting with knees higher than hips can be fine for posterior sitting, but (b) this posture is bad advice for forward sitting.

To control thigh-torso angle, a seat should tilt forward or straddle for forward sitting, be relatively horizontal for erect sitting, and tilt backward for posterior sitting (see Figure 7). However, user preferences and published recommendations for seat tilt vary widely. Disagreement about whether a seat should be fixed in posterior inclination, in anterior inclination, or be adjustable in all inclinations, is in part due to the failure of the investigators to consider that different types of sitting activities may alter physiologic and user-preference responses.[10,16,18]

Figure 7
To control thigh-torso angle, a seat-pan should (a) tilt forward or straddle for forward sitting, and (b) tilt backward for posterior sitting.

Backless kneeling chairs ("Balans" type) may effectively maintain thigh-torso positioning for forward and erect sitting, but are not recommended for posterior sitting. Backless kneeling chairs are rarely successful for computer users (see Figure 8).



a b

Figure 8
(a) Backless kneeling chairs are useful for forward-sitting activities; (b) backless kneeling chairs are less effective for posterior-sitting activities.

In many postures, the degree of vertical convexity in a backrest affects the degree of lumbar lordosis.[10,19] Ideally, the size of the vertical convexity of the support should match the height and radius of the user's lumbar mid-range concavity. Matching backrest contour and placement to the user is often difficult due to the variability in the height and size of lumbar curvature in the population.[20]

Methods to match the curvature of the backrest to the curvature of the user should begin with assessment of the full range of available lumbar with hip range-of-motion in the sagittal plane, followed by identification of the mid-point of this range. At this mid-point position, the thigh-torso angle can be measured along with a measurement of the depth of the lumbar lordosis apex. For teaching purposes, I have developed a 6-point scale for lumbar sizes with size 1 being the flattest mid-range lumbar position and size 6 being the most lordotic mid-range lumbar position. Lumbar sitting-support and chair backrests can be sized on the same 6-point scale (see Figure 9).[21]

In some cases, the thigh-torso angle has a greater effect on lumbar positioning than the backrest curvature. A properly fitted back rest can be ineffective if used in a seat too low to preserve the thigh-torso angle. This is especially true in people with less than 95° of hip flexion range of motion and in people with lumbar-extension bias.

Figure 9
(a) An aggressive chair backrest, size 6 [Hag Splitback];
(b) an average chair backrest, size 4 (Alba Ergonomic];
(c) a mild chair backrest, size 1 [Cordi Pelly Executive].

Chairs, desks, and work surfaces must be regarded as a unit. Individuals will adjust their chairs to accommodate comfort of the upper limbs and eyes despite discomfort and undesirable positioning in the trunk and legs. The height of the desk must be derived from the height of the chair and the user's build, and the dimensions of the chair must be derived from the build of the user.[10,20]

Seating and work surfaces should be scaled to the size and structure of each user. Unfortunately, furniture is often marketed as "one size fits all" without consideration of the postural compromise a bad fit imposes on the smaller, larger, and differently proportioned individual.

Traditional furniture in the United States is too large for most women and many men, as it is designed for the average American male body size and type, usually a 5'10" male weighing 150 pounds. Conversely, most backless kneeling chairs are too small for many adults, and they compromise the thigh-torso angle in the same way as does a seat that is too low. The Balans chairs sold in the United States were originally designed for a child's frame and were marketed here to accommodate standard desk heights. An adult-sized kneeling chair requires a desk to be raised five to eight inches over standard height, which positions the user in a sit-stand posture.

Sitting can be constraining or dynamic depending on the nature of the seated activity. Driving and computer work are generally more constraining than general clerical work.

When sitting on small surfaces or with knees higher than the buttocks, the weight of the trunk is transmitted to the seat through the bony areas of the ischial tuberosities and coccyx. When sitting on seats higher than the length of the lower leg, pressure is transmitted to the distal thighs. Direct pressure on the back will vary with the inclination and shape of the back rest. These areas of high pressure can lead to diminished blood flow, numbness, and pain.[10] Pressures are controlled with proper seat and back height, tilt, upholstery, and contouring.

No chair will ever be designed that is good for all purposes and that fits all people. There is no such thing as the one and only healthful sitting posture, and few people are of so-called "average" build.

Physical demands of sleeping

Sleeping is non-weight-bearing. Depending on sleeping habit, the lumbar spine may assume many positions during a night's sleep. Greatest lower-trunk pressures are on the greater trochanteric and sacro-coccygeal areas. Some people change positions up to 60 times during a normal night's sleep, while others change positions as little as ten times.

Many factors affect habitual sleeping postures, including breathing and swallowing patterns, body build, and the health status of various organ systems. For instance, people with a large thoracic kyphosis, forward head, or primitive swallow generally sleep on their sides. If they must sleep supine, they need many pillows to find comfort. These habitual sleeping postures are very difficult to change, and must be considered when making a furniture prescription.

A good bed will provide a level platform for sleeping and be soft enough to distribute weight evenly from prominences to hollows for any sleeping posture. It should encourage mid-range spinal alignment in the frontal and sagittal planes. Poor alignment can result either from a sagging mattress or from a mattress that is too firm (see Figure 10).

a b

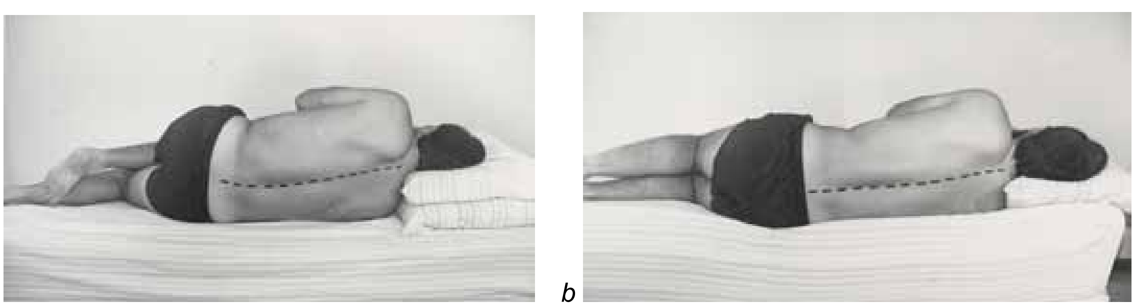


Figure 10
(a) Poor spinal alignment in the frontal plane results from lying on a firm surface. (b) Spinal alignment is best on a softer, more contouring surface.

Measurement of body weight and body contour is important to mattress and sleep support prescription. People with lower body weights or greater body curves have the most difficulty achieving good postural alignment during sleep.

Firm traditional orthopedic innerspring mattresses generally require a body weight of about 140 pounds to achieve good contourability, and will begin to sag with body weights approaching 200 pounds. Thus, individuals weighing less than 140 pounds generally sleep on mattresses that are too firm to distribute body weight and contour to the body's curves. They experience even more difficulty with positioning if they have relatively large body contours.

Contemporary mattresses made of alternative materials (e.g., water cylinder, partitioned air core, visco-foam) provide superior contouring and support over traditional mattresses. However, they generally perform less well in thermo-regulation (e.g., they are sweaty-hot or cold). Contemporary innerspring mattresses with higher coil counts or flexible slat foundations improve the contourability of innerspring mattresses significantly, but contouring is not as precise as with the alternative mattresses. Symptomatic people may need to explore several options to find an effective and comfortable sleeping solution.

Body contour measurements for sleep support in the frontal plane include measurement of hip and shoulder development. Hip development is the measured difference in circumference between the waist and hips. The average American woman has a hip development of 12 inches. Hip development greater than 10 inches usually requires additional contouring in a mattress or sleep support, especially for support in the frontal plane (see Figure 11). Shoulder development measurement is the difference in circumference between the shoulders and waist. Broad-shouldered and well-muscled men often have a shoulder development greater than 10 inches, and also require additional mattress contouring.

Figure 11
Use of a lumbar sleep support to correct body alignment on a mattress that is too firm.

MATCHING FURNITURE DESIGN TO FUNCTIONAL LOSS

The furniture prescription begins with identification of the specific design characteristics needed to compensate for the low back's unique presentation of functional loss. Furniture with these design features are then fitted, with careful attention to match the furniture to the body's size and contour (see Figure 12).

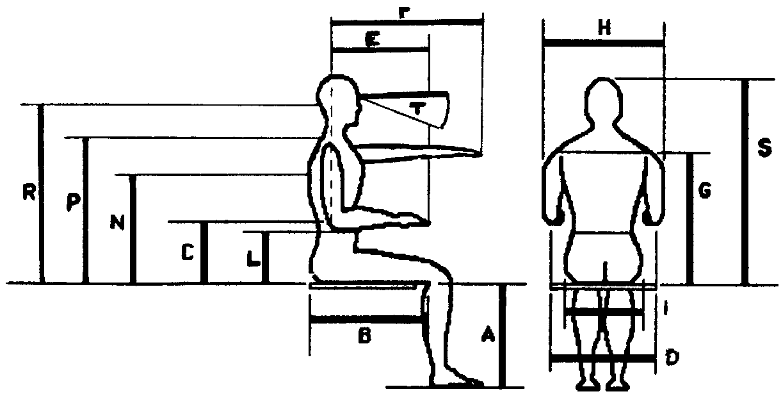


Figure 12
Furniture dimensions must match the body's size and contours.

Body measurements include the identification and measurement of the mid-range lumbar curve and the thigh-torso angle that best supports this degree of lordosis. For activities requiring vision, focus distance is also measured.

Furniture design for position sensitivity

Furniture controls lumbar positioning by controlling the position of the pelvis, primarily with thigh-torso angle control and secondarily with external lumbar support. The furniture prescription should address both positioning mechanisms, as improper application of one can negate the positive effect of the other.

External support over the abdomen, the lateral waist area, or the lumbar spine itself is designed to block movement of the lower trunk. Chair backs, chest rests, lumbar-sitting support cushions, contour mattresses, and lumbar sleep supports are all examples of external positional support. The size and placement of these supports are essential to their successful use.

The furniture prescription begins with identification of the specific design characteristics needed to compensate for the low back's unique presentation of functional loss.

Routine use of the same chair back, lumbar-sitting support, or sleep support for all patients should be avoided. A curvature that is mid-range for one individual may be end-range flexion or extension for another (see Figure 13). In addition, body size and contour, physical demands of the activity, and the presence of lumbar pathology may necessitate additional modification of the support.

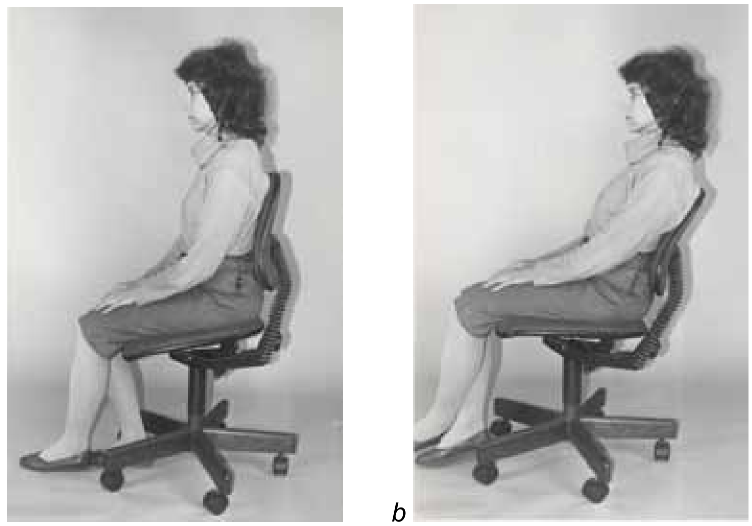
a b c

Figure 13
(a) Lumbar support, size 2 [Obusforme];
(b) lumbar support, size 3 [Sacroease];
(c) lumbar support, size 6 [McKenzie lumbar roll].

In the presence of a symptomatic flexion or extension bias, the lumbar curvature size is decreased or increased by one size and the thigh-torso angle adjusted accordingly. Thus, the same size lumbar support prescribed as an extension bias support for someone with a flatter mid-range size, could also be prescribed as a flexion bias support for someone with a more lordotic mid-range size.

One occasionally encounters an individual with greatest relief at the extremes of lumbar flexion, extension, or rotation/side-bending. These individuals should be fitted with a lumbar support just short of their end-range-of-motion lumbar position. Most people experience an increase in symptoms in end-range-of-motion lumbar positions, and joints should not be bent or stretched to their limits of motion for prolonged periods, especially if under load.

For the position-sensitive problem, the thigh-torso angle should remain relalively constant regardless of the activity. For most individuals, the preferred thigh-torso angle approximates 135° (see Figure 14).



a *b*

Figure 14
A forward seat tilt chair will preserve an open thigh-torso angle in a position-sensitive person as the body's center of mass shifts (a) forward and (b) backward.

Restricted mobility in the adjacent torso and hips will require additional adjustment in the thigh-torso angle. For example, a very arthritic hip or a stiff and kyphotic thoracic spine will produce increased lumbar kyphosis during sitting unless the seat-back angle is increased.

The best mattress for the position-sensitive lumbar problem provides either a rigid, nonsagging base of support, covered with very pliable resilient material on the surface to provide contouring, or a custom-contoured surface. Individuals with hip or shoulder development greater than 10 inches may require between 4 inches to 6 inches of contouring on the surface, while individuals with development less than 8 inches need only 2 inches to 3 inches of contouring. The contouring material must be very soft for individuals who weigh less than 140 pounds.

For sleep, an adjustable hospital-type mattress, or bed wedges and pillows, can be used to control thigh-torso angle. Due to the many physiologic factors affecting sleep, it may be very difficult to change habitual sleeping postures (e.g., from supine or prone to side lying). It is preferable to try to incorporate the preferred thigh-torso angle into existing sleeping orientations. For instance, it is better to instruct supine sleepers to put a pillow under their knees to sleep, than to instruct them to sleep side lying in a fetal position.

Measurement of focus distance and angle is an important part of the seating prescription for the position-sensitive person. All too often a chair or lumbar-sitting support is prescribed without considering the requirements of vision. Adaptation of the work surface with slant boards, book holders, and computer valets may be critical in controlling lumbar position (see Figure 15). Corrective lenses for a particular activity may also be required.

a  b

Figure 15
A copy holder can change sitting posture from (a) forward to (b) erect by accommodating visual focus requirements.

Furniture design for weight-bearing sensitivity

In the furniture prescription, load relief and load shifting may be more important than the positional support of the furniture. The effect of load on the spine and how it is influenced by weight, posture, dynamic forces, asymmetries in loading, muscle recruitment and different time factors (duration, frequency) are important.

There are three principles in furniture design important for the weight-bearing-sensitive individual: (1) the redistribution of vertical loads to body parts other than the spine; (2) frequent body movements to shift loads, and (3) recruitment of the postural muscles for upright work. Furthermore, seating materials used in equipment and vehicles where vibration is a factor, should have the capacity to attenuate shock.

Mattress and sleep-support prescriptions for the weight-bearing-sensitive individual are usually unnecessary. Vertical loading is at its least during recumbency.

Reclined postures are preferred for seated activities, and will produce little load through the spine if the spinal curves, especially the cervical and lumbar curves, are well supported. The larger the backrest, the less the weight-bearing load. The cervical spine is most at risk if the requirements of vision cause the head and neck to assume an erect or forward bent position, while the rest of the body is semi-reclined.

Forward and erect center-of-gravity tasks are more difficult for weight-bearing-sensitive people than reclined tasks. In forward and erect activities, a chair back support provides little relief from load bearing. Whenever possible, traditionally forward and erect tasks, such as writing and computer use, should be converted to reclined tasks, with focus-surface and work-surface redesign. Examples of such modifications indude closer positioning of computer screen and keyboard, and the use of a slanted desk Weight-bearing stress can also be redistributed through the torso, upper extremities, or feet (see Figure 16).

Figure 16
The Ergomax torso-rest chair reduces load bearing during forward center of gravity tasks.

Armrests, if properly fitted, help to better distribute load and can be used to superimpose a traction force through the lumbar spine. For greatest effect, arm rests should be fitted to a height of one inch above the elbow of the slightly abducted humerus for erect tasks. A work surface of the proper height can also be used as a load-bearing surface through the arms, for forward tasks. The work surface should be 2 to 3 inches above the elbow for weight-bearing relief. For those in forward-sitting occupations and without desks (e.g., dentists) one or two industrial armrests can provide some weight-bearing relief.

Control of weight-bearing stresses can be enhanced by frequent body position changes. Furniture should be designed to encourage these frequent position changes. In chairs, this is accomplished with floating seat pans, rocking bases, and dynamic back rests. Work surfaces should be mobile to allow the worker to maintain a constant and effective focus distance during frequent body position changes. This is accomplished with flexible work surfaces and aids, such as flexible readers, computer monitor valets, and easily adjustable drafting desks.

Backless kneeling chairs are contraindicated for the weight-bearing-sensitive individual. These chairs neither give the user an opportunity to move adequately to shift loads, nor to redistribute loads to a backrest, armrest, or to the feet.

Seat cushions made of viscoelastic shock attenuating materials minimize vibration in motor vehicles. Truck drivers who are weight-bearing sensitive can purchase seats with built-in air shock absorbers.

Patients with significant spinal weight-bearing loss may require a traction device for upright activities, made with harnesses suspended from above or a traction-suspension frame device.

Furniture design for constrained posture sensitivity

The primary goal for the individual sensitive to constrained postures is to be in near continuous motion, whether during daytime work, during leisure activities, or during sleep.

The seating design characteristics effective for shifting loads are also effective for stasis relief. In mattresses, load shifting is enhanced with air and water mattress construction.

Furniture design for pressure sensitivity

Reduction of direct pressure can be accomplished by distributing load bearing over a larger surface area, by evening out or eliminating the points of greatest load-bearing contact with contouring materials, or by shifting the loads to another body region.

Seat-pan size and height are critical to those with pressure sensitivity over the ischial tuberosities or coccyx when sitting. These individuals should use the largest possible seat pan that does not interfere with freedom of movement at the knee. Seat pans should extend to within two inches of the popliteal space. Seat-pan height requires special measurement as it affects the size and location of the load-bearing areas. If the seat-pan is low, pressure is concentrated on a smaller surface toward the posterior thigh, pelvis, and sacrum. If the seat-pan is too high, pressure is increased over the distal thigh. Since saddle-seats distribute much of the body weight away from the buttocks into the feet, they are sometimes also effective in accommodation buttock and coccyx sensitivities.

Individuals who are pressure sensitive over the lumbar spinous process should use a backless chair, a larger backrest that supports the thoracic spine as well as the lumbar spine, or a contoured backrest that is sagitally convex and horizontally concave. A vertical convexity preserves the neutral lordosis, and is generally important for position sensitivity. However, the presence of a vertical convexity without a horizontal concavity concentrates the entire force of the support over the sensitive posterior spinous processes (see Figure 17).

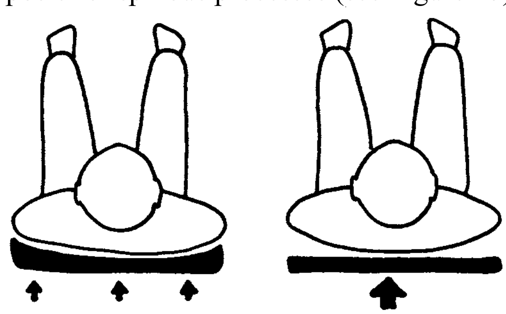


Figure 17
Chair backs and lumbar cushions without a horizontal concavity put excessive pressure over the sensitive posterior spinous processes.

The furniture design characteristics effective in shifting loads can also be used to control pressure sensitivity.

The same materials and methods recommended for wheelchair cushions and hospital mattresses for the prevention of decubitus ulcers are also effective for the relief of pressure sensitivity in the low-back injured. Contour should either match the contours of the body (e.g., contoured seat pans), be cut away over the sensitive area (e.g., coccyx cut-a-way cushions), or be made of a soft, resilient, contouring material (e.g., air cushion).

While it is possible to find office furniture with contoured or variable firmness seat pans, it is rare to find such amenities in residential furniture.

Mattresses, especially the firm "orthopedic" variety, are often too firm on the surface for the pressure-sensitive individual. Such mattresses can be modified with mattress overlays made of soft, resilient material such as foam, air, or gel. One recent study of mattress overlays revealed that the commonly used egg-crate foam was one of the least effective pressure-reducing surfaces when compared to air, gel, and flat sheets of foam.[22]

Seat-pan angle can be adjusted to shift load-bearing surfaces away from sensitive areas. A tender coccyx is often relieved by a forward or sloping seat pan during seated tasks.

<> <> <>

To be effective and safe, furniture for the low-back injured individual should be as carefully prescribed and fitted as shoes and orthopedic appliances. Clinical assessment of key functional loss areas – sensitivity to position, weight-bearing, constrained postures and pressure – is critical to successful furniture prescription.

The functional loss classifications and fitting principles presented here also apply to other aspects of physical management of people with low-back disorders. These classifications may also be useful in the prescription and fitting of external supports, orthotic devices, daily living aids, and in the application of therapeutic exercise.

Sound application of furniture fitting principles to furniture design may decrease the incidence of low-back pain in the healthy population. Furniture can control postures, loads, movements and pressures on the lumbar spine, and probably reduces environmentally induced cumulative trauma. Although it is not known at what precise limits physical stresses become harmful or how individ-ual factors influence those limits, a great deal of useful information does exist. This knowledge should be used to reduce the environmental factors that stress the lower back.

REFERENCES

1. Bohannan RW, Gajdosik RL, LeVeau BF: Relationship of pelvic and thigh motions during unilateral and bilateral hip flexion. Journal of American Physical Therapy Association 1985;65:1501-150.
2. Keegan JJ: Alterations of the lumbar curve related to posture and seating. J Bone Joint Surg 1953;35A:589-603.
3. Grandjean E, Hunting W, Pidermann M: VDT workstation design: Preferred settings and their effects. Human Factors 1983,25:161-175.
4. Nachemson A: Toward a better understanding of low-back pain: a review of the mechanics of the lumbar disc. Rheum and Rehab1975;14:129-143.
5. McKenzie R: The Lumbar Spine: Mechanical Diagnosis and Therapy. Waikanae, New Zealand: Spinal Publications, 1981.
6. Kelsey JL, Hardy EJ: Driving of motor vehicles as a risk factor for acute herniated lumbar intervertebral disc. Am J Epid 1975;102:63-73.
7. Chaffin DB, Andersson G: Occupational Biomechanics. New York, Wiley, 1984.
8. Leuder R: Adjustable furnishings. Contract1985:27-.202-205.
9. Pope MH, Frymoyer JW, Andersson G (eds):Occupational Low Back Pain. New York, Praeger Publications, 1984.
10. Kroemer KH, Robinette JC: Ergonomics in the design of office furniture. Industr Med Surg 1969,38:115-125.
11. Vollowitz E: Prescription and fitting seminars (unpublished course notes). Oakland (Berkeley) Calif, Back Designs, 1985.
12. Hill SG, Kroemer KH: Preferred declination of the line of sight. Human Factors 1986,28:127-134.
13. Harmon DB: The coordinated classroom. American Seating Company (monograph). Grand Rapids, Mich., 1951.
14. Bendix T, Bloch I: How should a seated workplace with a tiltable chair be adjusted? Applied Ergonomics 1986,17-.127-135.
15. Andersson G, Chaffin DB, Pope MH: Occupational Biomechanics of the Lumbar Spine in Pope MH, Frymoyer JW, Andersson G (eds): Occupational Low Back Pain. New York, Praeger Publishers, 1984, pp 39-76.
16. Mandal AC: The seated man (Homo Sedens), the seated work position, theory and practice. Applied Ergonomics 1984;15(2):83-90.
17. Mandal AC: The correct height of school furniture. Human Factors 1982,24:257-269.
18. Bendix T, Jorgen W, Flemming J: Comparison of office chairs with fixed forward or backward inclining, or tiltable seats. Eur J Appl Physiol 1985;54:378-385.
19. Andersson GB, Murphy RW, Ortengren R, et al: The influence of backrest inclination and lumbar support on lumbar lordosis. Spine 1979;4(1):52-58.
20. Bex FH: Desk heights. Applied Ergonomics 1971;2:138-140.
21. Vollowitz E: Lumbar Sitting Support Sizing Chart. Oakland (Berkeley), Calif, Back Designs, 1984.
22. Krouskop TA, Williams R, Herszkowicz I, et al: Evaluating the effectiveness of mattress overlays. Rx Home Care 1985;7(12):97-103.