Ergonomic Seating?

The Perfect Chair?

The Perfect Work Posture?

Backs, Sitting & Ergonomic Chairs

- Up to 50% of MSDs
- Lifetime risk - 80% of people
- Maximum risk - 20-45 years old
- Risk factors:
  - Frequent heavy lifting
  - Poor posture
  - Static sitting

We Need to Sit

- Energy – sitting requires 20% less energy than standing.

We Need to Sit

- Efficiency - if supported and reclined, intradiscal pressure is less than that for erect standing.

We Need to Sit

- Effectiveness - sitting increases postural stability for fine motor tasks.

Why Do We Sit?

- Equality – sitting reduces anthropometric variability.

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Why an Ergonomic Chair?

- **Economics** -the average office loses over $7300 per employee per year in poor productivity and medical and Workers' Compensation claims (The Bureau of Labor Statistics).
- Over 50% are low-back injuries. Poor chair design contributes to poor seated

posture which plays a major role in these injuries (e.g. Secretary Back Syndrome).

Musculoskeletal Discomfort

(Ong *et al.*, in Work with Computers, 330-337, 1989)

- Survey of 672 full-time computer users:
- Complaints related to poor ergonomic furniture, including the chair.

Musculoskeletal Discomfort

(Ignatius *et al.*, J. Human Ergology, **22**:83-93, 1993)

- Survey of 170 women typists working at computers
- Mismatch between chair height and desk height and poor furniture design related to symptoms.

Ergonomic Survey of the Social Services Administration, USA

(Lueder, 1997)

Ergonomic Chair Design?

- Who advertises their chair as "not an ergonomic design"?
- Can you choose the best chair solution from "off-the-shelf" ergonomic chairs?

How Should We Sit?

Risk = Posture X Exposure

ANSI/HFS 100-1988

Myths of Ergonomic Seating

1. Ergonomic seating always requires a single, 'cubist' (90° upright) postural orientation that is independent of the user's task (Dainoff, 1994).
2. You can judge how ergonomic a chair is by briefly sitting in it.
3. Users should be able to adjust everything.
4. Users don't need training on how to sit in a chair (Dainoff, 1994).
5. One chair design will provide the best fit for all users.

Proper Ergonomic Posture?

- Anthropometric reference diagram (90° angles) IS NOT a required ergonomic posture!
- Reclined postures often are preferred (Grandjean, 1988).

Lumbar Support

- In unsupported sitting or forward leaning the lumbar spine may be

in kyphosis, which is indesirable.
- During supported sitting the lumbar spine should be maintained in lordosis by an adjustable lumbar support.

Seat Pan Design

- Proper sitting requires pelvic rotation that creates lumbar lordosis.

Ischial Tuberosities

- Sitting concentrates the forces on the ischial tuberosities (sit bones).

Seat Pan Design

Posture and Lumbar Disc Pressure

(Nachemson, 1974)

- Lumbar disc pressure varies with back posture and the load in the hands.
- Lumbar disc pressure is lowest for a supported, reclined posture.

Back Muscle Pain

Backrest angle and muscle activity

(Andersson and Ortengren, 1974)

- Lumbar, thoracic, and cervical muscle activity all decrease with increasing backrest inclination up to 110°.

Work Postures

(Park et al., 2000)

- Effects of work postures on muscle activity tested

Preferred Seat Angle

- Both lumbar disc pressure and back muscle activity are lowest with a supported recline angle of 110° - 130°.

Adjustable Back Support

(Coleman *et al.*, Ergonomics **41**: 401-19, 1998)

- Studied 123 office workers (43 men, 80 women) over a 5 week period: a high proportion of chair users make height adjustments to their lumbar back support.
- Adjustment frequency is higher for older workers than younger workers.

Chair Support

- Buttocks and back need support.

Keegan's Normal Posture

- Abdominal angle is ~135 °.

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Balan's Chair: Normal Posture

- Research findings don't support claims that this design will decrease low back pain (Lander *et al.*, Spine **12**: 269-72, 1987).

Mandal's Forwards-tilting Posture

- A proper spinal posture can be maintained by forwards sitting if the person has a seat pan that tilts and they use an angled worksurface.

Lots of balls?

- Sitting on balls can put the body in Keegan's normal posture, but isn't a solution for extended use.

Saddle chairs

- Work by Keegan and Mandal forms the basis for saddle chairs.

Sitting in Context

- Whether or not a chair design is ergonomic can depend on the task.

Neutral Posture

- Neutral posture in microgravity is similar to the seated postures shown (Congleton, 1999).

Neutral Posture in Microgravity

- Neutral posture in microgravity can be seen for a sleeping astronaut.
- Is this really the posture we should adopt in gravity?

Posture and Lumbar Disc Pressure

(Wilke et al., 1999)

- Lumbar intradiscal pressure can be recorded at L4-L5 during different standing, sitting and lifting postures.

Posture and Lumbar Disc Pressure
(Wilke et al., 1999)

- Intradiscal pressure during reclined, supported sitting is 50% less than that for erect standing.

Dynamic vs. Static Sitting
(van Dieën et al. Ergonomics, June, 2001)

- Tested 3 chairs:
  - Fixed Angle – FA (95º)
  - Dynamic Angle – DA
  - Dynamic Angle – DB
- Subjects worked for 3 hours on CAD, Word processing and reading tasks.
- Spinal elongation measured.
- Neck posture measured.
- Back EMG measured.

Dynamic vs. Static Sitting
(van Dieën et al. Ergonomics, June, 2001)

- Spinal elongation significantly greater for dynamic chairs.
- Neck posture unaffected by dynamic sitting.
- Back EMG depends on the task.
- Dynamic office chairs should NOT be locked.

Dynamic vs. Static Sitting
(van Deursen et al., 1999)

- After 1 hour, there is spinal shrinkage with static sitting, but spinal expansion with dynamic sitting where the seat pan swivels.

Preferred Seat Angle

- Both lumbar disc pressure, back muscle activity, and comfort ratings are lowest with a supported recline angle in the range of 110° - 130°.

Lumbar Support

- During supported sitting the lumbar spine should be maintained in lordosis by a contoured chair back lumbar support.

Reclined Sitting

- Reclined sitting preserves Keegan's normal posture but opens the popliteal arch and ankle angles, as well as allowing the back to recline against a contoured support.

Neutral Sitting Posture

- Neutral sitting posture for 5th and 95th percentiles (Congleton, 1999).

Chair Backrests

(Veraga & Page, 2000, Applied Ergonomics, 31, 247)

- Tested effects of 6 different chair backrest designs on back support.
- Backrest design significantly affects measured dorsal (shoulder blade) and lumbar contact time.

Effects of a Chair Headrest

(Monroe et al., 2001, Proc. HFES, 1,1082-6)

- Studied effects of a reclined posture with headrest on typing.
- Found significantly less muscle activity with this posture for the:
  - Neck (>35% reduction)
  - Back (> 64% reduction)
- No difference in typing accuracy.

Popliteal Arch

- Compression at the popliteal arch (back of the knee) can impair leg circulation and cause nerve compression.

Popliteal Angle

- The popliteal arch (back of the knee) should not be in contact with the chair seat pan.
- The popliteal angle should be > 90°.

Seat Height

- Seat height should be adjustable and set to allow feet to be placed

on a stable surface.

- When seat height cannot be suitably adjusted, use a footrest.

Crossing Legs

✕ Poor posture

Headrests and Neck Posture

- Sitting head height for 5th and 95th percentiles.
- Adjustable height headrests are necessary for a properly supported neck posture.

Adjustment Features for an Ergonomic Chair

1. Seat height
2. Back rest height
3. Swivel - ability to turn while seated
4. Back tilt adjustment
5. Adjustable arms
6. Seat tilt adjustment
7. Ability to lean back
8. Ability to "track" posture changes
9. Carpet casters/hard floor casters
10. Intuitive, easy-to-use controls

Ergonomic Chair Controls

- Ensure that chair controls don't require awkward adjustments.
- "The key is…to design adjustability controls that are easy to understand and easy to use (Helander *et al.*, 1995)
- Controls with long levers most preferred.
- Controls are operable while sitting.

Ergonomic Chair Controls?

101 Rotations!

- Watch out for chair controls that require awkward adjustments.

Ergonomic Chair Control Adjustments (Helander *et al.*, 1995)

- 24 different types of chair controls on 26 different chairs investigated in 3 experiments (20 Ss).

- Controls with long levers most preferred.
- The more the controls, the more the adjustments and the longer the adjustment time.

Benefits of Chair Arm Rests

- Improved wrist deviation?
- Improved shoulder abduction?
- Improved forearm support?
- Improved typing comfort?

Cornell Chair Arm Study

(Barrero, Hedge & Muss, 1999)

- 24Ss study
- Men/women
- 5/50/95th %iles
- 4 chair arm designs
- Keyboard on flat keyboard tray

Cornell Chair Arm Study

(Barrero, Hedge & Muss, 1999)

- No significant differences between chair arm designs in wrist posture during typing at a keyboard on a flat tray.
- No differences in upper body posture.
- Wrist posture is outside of a neutral zone of wrist movement.

Chair Armrests

- Look at user's arm positions on a chair arm rest when the chair is adjusted for sitting comfort.

Discourage Poor Seated Posture

Neutral Working Posture

Ergonomic Chair Designs

(BSR/HFES100, 2002; ISO 9241-5 , 1998; CSA-Z412.00, 2000, & BIFMA, 2001)

- "The purpose of good seating is to provide stable body support in a dynamic posture which is comfortable over a period of time, physiologically satisfactory, and appropriate to the task or activity which is to be performed."

Ergonomic Chair Requirements (BSR/HFES 100, 2002)

- Adjustable Seat Height
  - 11.4 cm in range 38-56 cm

- Seat Pan Angle Recline and/or decline
  - <= 6° total
- Seat Pan-Backrest Angle
  - >=90°
- Seat Pan-Backrest Recline
  - 0-15°
  - recommended range = 0-30° (if >30° a head rest is needed)

Ergonomic Chair Recommendations
(BSR/HFES 100, 2002)

- Seat Pan Depth
  - <=43cm
- Seat Pan Width
  - >=45cm
- Backrest Height and Width (top of backrest)
  - >= 45 cm above compressed seat height (CSH)
- Backrest Lumbar Support
  - 15-25 cm above CSH
- Backrest width
  - >=36cm
- Armrest height
  - 17-27cm (fixed)
  - 18-27cm above CSH (adjustable)
- Armrest span
  - 46cm
- Chair casters
  - Appropriate for type of flooring at workstation