Office Ergonomics - 101

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Disclosures

• I (Jay M. Kapellusch) have nothing to disclose

• I have not received financial or technical support from any manufacturer or agency to produce this work

• Products shown in this presentation are of my own selection and are among those that I use in daily practice

• All recommendations provided are based on published literature and/or my professional judgment

Why Worry about Office Ergonomics?

• Computer use/office work is correlated with relatively high prevalence of low-back pain, and MSDs of the hand/wrist, neck and shoulder.

• Generally associated with sedentary work which can have long-term negative health effects

• Solutions are deceptively simple — interventions require careful thought and cooperation of the worker
Overview
- Risks & Prevalence of MSDs
- Workstations & Working Postures
- Chairs
- Setting Desk Height
- Keyboard & Mouse
- Sit/Stand Workstations
- Other Aspects
- Conclusions & Suggestions

Risk & Prevalence of MSDs

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Sources of Risk
- Biomechanics
  - Head rotation & Neck Flexion/Extension
  - Shoulder flexion/abduction
  - Wrist postures (mouse/keyboard)
  - Sitting posture (lack of back support)
  - Work organization
  - long hours, deadlines, etc...
- Psychosocial
  - Job pressure
  - Lack of supervision/coworker support
  - Fear of job loss
- Miscellaneous
  - Multifocal lenses
  - Illumination
CTS

- Specific work circumstances might be associated with CTS, but current evidence has not been able to demonstrate a reliable causal association. [1]

<table>
<thead>
<tr>
<th>Activity</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Computer Use</td>
<td>1.7</td>
<td>0.8 - 3.6</td>
</tr>
<tr>
<td>Keyboard Use</td>
<td>1.1</td>
<td>0.6 - 2.0</td>
</tr>
<tr>
<td>Mouse Use</td>
<td>1.9</td>
<td>0.9 - 4.2</td>
</tr>
</tbody>
</table>


Upper Limb Symptoms & Disorders [2]

- Most common hand/wrist disorder: extensor tendonitis, dorsal comp. 1
- Most common neck/shoulder disorder: somatic pain syndrome

<table>
<thead>
<tr>
<th>Symptoms/Disorders</th>
<th>Baseline Prevalence</th>
<th>1yr Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand/Wrist</td>
<td>38.8</td>
<td>37.5</td>
</tr>
<tr>
<td>CTS</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Forearm/Wrist</td>
<td>4.0</td>
<td>5.9</td>
</tr>
<tr>
<td>Neck/Shoulder</td>
<td>2.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>


The Keyboard Height Conundrum

- Potentially resolved with shoulder support

Risk Factors for Hand/Wrist MSDs

- Combinations of force, duration of exertion, and frequency of exertion create strain on the hand/wrist [4,5]
- Poor posture exacerbates this risk [5]
- Keyboarding parameters adapted from Gerr et al. [2]

<table>
<thead>
<tr>
<th>Factor</th>
<th>Keyboarding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Force</td>
<td>Up to 50g (&lt;1% MVC)</td>
</tr>
<tr>
<td>Hours of Sustained Exposure</td>
<td>Up to 4hrs</td>
</tr>
<tr>
<td>Work Pace</td>
<td>Steady typing (30-40 wpm on average)</td>
</tr>
<tr>
<td>Revised Strain index score</td>
<td>10-12 (borderline Hazardous)</td>
</tr>
</tbody>
</table>


Low-Back Pain

- Currently no evidence that occupational sitting is an independent risk factor for LBP [6]
- Nevertheless, LBP has a complex, multifactorial etiology and some workers clearly suffer LBP while sitting at work.
- No evidence that sit-stand workstations are effective at mitigating LBP [7]. However, sit-stand desks can reduce discomfort for those with little to no low-back pain [7].
- Here again, the literature has examples where postural changes are effective at mitigating LBP in specific individuals.


Body Position & Disc Pressure

- Prone: 55 lbs
- Standing at Ease: 110 lbs
- Leaning Forward: 130 lbs
- Sitting with Back Support: 100 lbs
- Sitting Upright: 150 lbs

Backrest Inclination & EMG

- Minimizes muscle activity & reach
- Sitting

EMG AMPLITUDE (µV)
Backrest Angle (°)


Rest Breaks and LBP

- No statistical difference in data-entry style productivity
- Approx. 25% less self-report mental fatigue with rest breaks

Adapted from [10] Sheahan et al., 2016. Appl. Ergon. 53, 64–70. DOI: 10.1016/j.apergo.2015.08.013

Work Organization

- Regular activity breaks are beneficial to overall health
- Some evidence that regular breaks are more effective than prolonged sedentary combined with regular work-outs
- Regular postural changes can alleviate back pain and discomfort among pain-developers
- Solution: Structure workflow and policy to encourage regular breaks from sitting
Common Stressors

- Several studies report work organization factors as likely increasing risk for pain/MSDs:
  - Overtime
  - Excessive workload & Unrealistic Deadlines
  - Unaccustomed and heavily seasonal work
  - Lack of rest breaks
  - Sustained keying for more than 4 hours per day

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Workstation & Working Postures

Old Recommendations
Current Recommendations [x]

- Shoulder also abducted 30°
- 110° - 120° Trunk Extension
- At or below elbow height
- Feet on Floor
- Neck Flexion ≤ 3°
- Eye Height ≥ 6”
- Against Chair
- Neutral wrist posture — no radial deviation while mousing


Computer Workstation Recommendations

Provide:
- Adjustable chair
- Foot rest (if needed)
- Adjustable work surface
- Split keyboard (if preferred)
- Wrist support/arm support
- Document holder
- Augmented lighting
- Adjustable display (height)
- Frequent, short rest breaks

**Involve worker(s) in the selection of equipment**

General Recommendations

- Avoid:
  - Production incentives
  - Production pressure
  - Unrealistic deadlines
  - Overtime
  - Supervisory & peer pressure and psychosocial stresses
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Chairs

Selecting a Chair

• Minimum Attributes of a Good Chair
  • Adjustable Height
  • Adjustable Backrest
  • Lumbar Support
  • Ability to Recline
  • Adjustable Arm Rests

Chair Size
Setting Desk Height

- First, set chair height so that feet are flat on floor and legs are supported.

 too low  

 too high

- Adjust back-rest to comfortable position
- Relax arms at side
- Measure seated elbow height
- Set desk height (top surface) to at or up to 1.5" below seated elbow height*
  - Note: Check for adequate leg clearance

* For standing stations, set initial height at standing elbow height
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Keyboard & Mouse

Traditional keyboard

Fixed split keyboard

Keyboard Slope

- Standing workstation
- Fixed height from floor

Positive Slope

Flat

50º Extension

Negative Slope

30º Extension
Prototyping Additional Negative Slope

Keyboard Width
Mouse Styles
(Forearm Rotation)

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Sit/Stand Workstations

Styles of Sit/Stand Workstations

• Desk-top Convertible

• Convertible (powered and manual)

• Two-desk
Sit/Stand Workstations

- Potential Benefits:
  - Increased physical activity
  - Improved overall health
  - Reduced musculoskeletal pain

- Perceived & Potential Drawbacks:
  - Increased leg/back pain
  - Disruptions to productivity
  - Lack of acceptance/adherence

Sit/Stand Usage

- Sit/Stand workstations appear to reduce sitting time by an average of 15 to 99 minutes [13]
  - Evidence is weak and based on studies of 3-12 months. No evidence of efficacy for longer durations

Sit/Stand Usage, n=1098 [14]

- Most Common Reasons for ceasing a standing session:
  - Felt like stood long enough (65-70%)
  - Switched to different work task (81-85%)
  - Discomfort (57-60%)
  - Felt tired (54-59%)

References:


Reasons for Non-Use of Sit/Stand Workstations

- Insufficient space or too small table tops [15,17]
- Unable to find the appropriate height [17]
- Problems with manual adjustment mechanism [16, 17]
- Problems with environment (e.g., collision with the pin board / cables / other furniture) [16]
- Social environment – feeling self-conscious if colleagues were not able to stand up [17]
- Unable to stand for longer periods [16]


Desk-Top Convertible

- Pros:
  - Inexpensive
  - Easy to deploy

- Cons:
  - Limited workspace
  - Difficult to adjust

Watch for:
- Stability/tipping
- Lift/lower force
- Lift range

- Sitting adjustment (too tall)?
- Sitting leg clearance
**Desk-Top Convertible**

**Pros:**
- Easy to adjust
- Large workspace

**Cons:**
- Slow to adjust
- Loud motors
- Expensive

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**Motorized Convertible**

**Pros:**
- Easy to adjust
- Large workspace

**Cons:**
- Slow to adjust
- Loud motors
- Expensive

**Watch for:**
- Memory pre-sets
- High-speed motors
- Quiet motors (<50db)
- Lift range
- Lowest height
Two-Desks

• Pros:
  • No adjustment
  • Large workspace

• Cons:
  • Extra equipment (cost)
  • Need more space

Two-Desk Approach — Fit

Two-Desk Sit-Stand Variant

Note: 4-8" Footstool
Setting Standing Height

Too Low
Good Height
Too High
Below Elbow
About at Elbow
Above Elbow

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Other Aspects

Multi-Focal Lenses
### Arm Support

Advantage:

- Low keyboard height

Potential Problems:

- No arm support (need good chair armrests)
- Increased wrist extension (use negative tilt on tray)
- No proximal working space (i.e., increased reach distances)

### Keyboard Tray

Advantage: Low keyboard height

Potential Problems:

- No arm support (need good chair armrests)
- Increased wrist extension (use negative tilt on tray)
- No proximal working space (i.e., increased reach distances)

### Alternative Seating

- Note: Foot Support
Lighting Solutions

Illumination level: ≤ 500 lux for computer work

Protect from Direct Glare

• Ideal: Monitor perpendicular to Windows
• Alternative: Glare shield

Conclusions & Suggestions

• Sedentary work/lifestyle is associated with an increasing number of negative health effects
  • Increase postural changes in the workplace through: regular rest breaks, adjustments to workflow, and equipment such as sit/stand workstations.
  • Biomechanics, physiology, and psychophysics suggest that certain computer activities should cause increased MSDs. However, epidemiological evidence is currently inconclusive.
Conclusions & Suggestions

• Work Organization factors such as lack of rest, temporary overloading (i.e., unaccustomed work), and overtime (i.e., over-exertion) appear to be more consistent problems than computer work per se.

• Though not yet “proven” over-use is likely a source of MSDs, especially for those highly exposed during work and during recreation (i.e., computer at work, computer at home).

Conclusions & Suggestions

• Perform keyboard and mousing tasks near elbow height
  • Slightly below for sitting, slightly above for standing

• Use equipment that encourages neutral hand/wrist postures.

• Sit with back supported and at a slight recline (e.g., 115º)

• Keep elbows slightly extended (i.e., elbow included angle > 90º)

Conclusions & Suggestions

• Office Ergonomics is highly preferential – what works for one might not work for another

• Have a variety of equipment options available
  • Keyboards, mice, chairs, etc…

• Involve employees in equipment selection
Conclusions & Suggestions

- Injured/recovering workers have special circumstances and might require special equipment.

- Regular changing of equipment might be beneficial/necessary.

- For example having multiple mouse styles that can be rotated throughout the working day

References


Q1: There is strong evidence that __________ is caused by prolonged computer use.

a) Carpal tunnel syndrome  
b) Extensor tendinitis  
c) Low-back pain  
d) Rotator cuff syndrome  
e) None of the above
Q2: What is the recommended keyboard position for a healthy worker?

a) Close to the body so that upper arm is relaxed, vertically, and elbow is flexed at 90º
b) At or slightly below elbow height and six or more inches forward on the desk so that the forearms are supported
c) Three or more inches above elbow height so that risk of hand/wrist pain is reduced.
d) On an adjustable keyboard tray

Q3: Which of the following statements best describes the science of office ergonomics?

a) Existing science and evidence can inform professional judgment and, in cooperation with workers, can be used to design effective working environments.
b) If all workstations are identically adjusted using established biomechanical and physiological principles, then most workers will be protected from injury.
c) There is little or no evidence for what types of work and equipment are effective or harmful, and so whatever the worker wants is fine.