# 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

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# 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*

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# Overview

- Risks & Prevalence of MSDs
- Workstations & Working Postures
- Chairs
- Setting Desk Height
- Keyboard & Mouse
- Sit/Stand Workstations
- Other Aspects
- Conclusions & Suggestions

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# 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 supervisor/coworker support
  - Fear of job loss
- Miscellaneous
  - Multifocal lenses
  - Illumination

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# CTS

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

| Activity | OR | 95% CI |
|---|---|---|
| General Computer Use | 1.7 | 0.8 - 3.6 |
| Keyboard Use | 1.1 | 0.6 - 2.0 |
| Mouse Use | 1.9 | 0.9 - 4.2 |

[1] Mediouni et al., 2014. JOEM. 56(2): 204-208. DOI: 10.1097/JOM.0000000000000080

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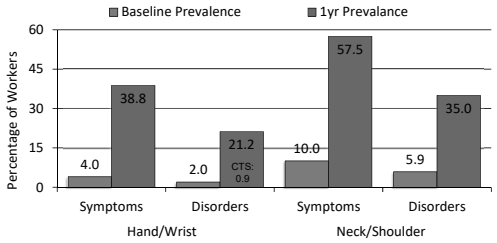
# Upper Limb Symptoms & Disorders [2]




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

[2] Gerr et al., 2002. Am J Ind Med, 41: 221-235. DOI: 10.1002/ajim.10066.

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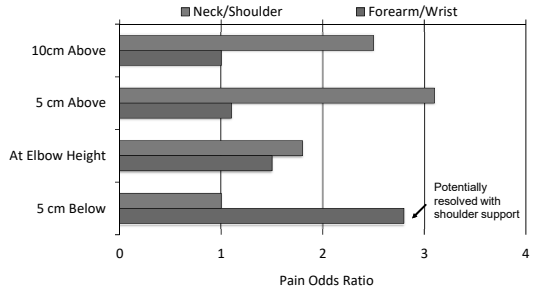
# The Keyboard Height Conundrum




[3] Bergqvist et al. 1995. Ergonomics. 38: 754-62. DOI: 10.1080/00140139508925147

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# 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]

| Factor | Keyboarding |
|---|---|
| Key Force | Up to 50g (<1% MVC) |
| Hours of Sustained Exposure | Up to 4hrs |
| Work Pace | Steady typing (30-40 wpm on average) |
| Revised Strain Index Score | 10-12 (borderline Hazardous) |

[2] Gerr et al., 2002. Am J Ind Med, 41: 221-235. DOI: 10.1002/ajim.10066.
[4] Harris-Adamson et al. 2015. BMJ. 72: 33-41. DOI: 10.1136/oemed-2014-102378
[5] Garg et al. 2017. Ergonomics. 60(7): 912-922. DOI: 10.1080/00140139.2016.1237678



# Low-Back Pain

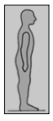
- Currently no evidence that occupational sitting is an independent risk factor for LBP [6]
  - Nevertheless, LBP has a complex, multifactorial etiology and some workers clearly suffer LBP while sitting at work.
- No evidence that sit-stand workstations are effective at mitigating LBP [7]. However, sit-stand 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.

[6] Roffey et al. 2011. Spine J. 10(3): 252-61. DOI: 10.1016/j.spinee.2009.12.005
[7] Agarwal et al., 2018. Ergonomics. 61(4): 538-552. DOI: 10.1080/00140139.2017.1402960



# Body Position & Disc Pressure


Prone
55 lbs


Standing at Ease
110 lbs

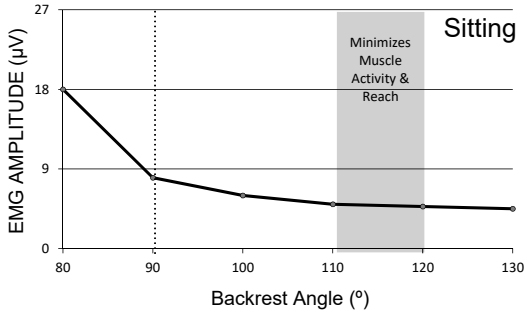

Sitting with Back Support
100 lbs


Leaning Forward
130 lbs


Sitting Upright
150 lbs

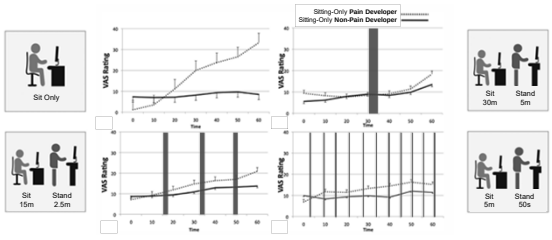
Adapted from: [8] Nachemson, 1981. Spine, 6(1): 93-97.
DOI: 10.1097/00007632-198101000-00020

# Backrest Inclination & EMG




Adapted from: [9] Andersson and Ortengren, 1974. Scand. J. Rehab. Med. 6(3): 115-121 PMID: 4417802

# Rest Breaks and LBP




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

Adaped 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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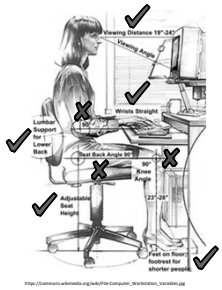
# Workstation & Working Postures

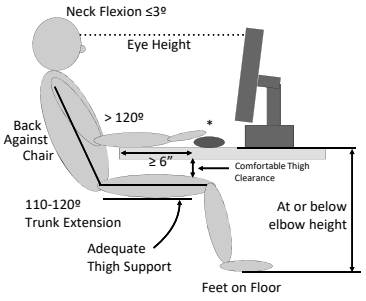


# Old Recommendations




https://commons.wikimedia.org/wiki/File:Computer_Workstation_Variables.jpg

# Current Recommendations [x]




* Neutral wrist posture — no radial deviation while mousing

Adaped from: [11] Marcus et al., 2002. Am. J. Ind. Med. 41, 236–249. DOI: 10.10002/ajim.10067

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# 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**

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# General Recommendations

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

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# Chairs

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## Selecting a Chair

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

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## Chair Size

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# Chair Size

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# Chair Size

A B C

Herman Miller Aeron Chair

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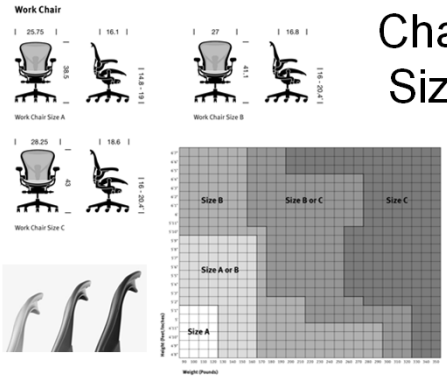
# Chair Size




Herman Miller Aeron Chair

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# Setting Desk Height

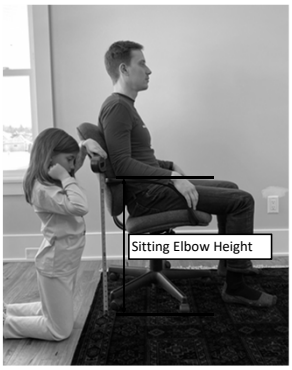
- First, set chair height so that feet are flat on floor and legs are supported.

Too Low

Too High

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

* For standing stations, *set initial height <u>at</u> standing elbow height*



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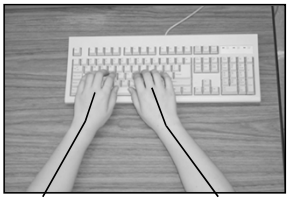
# Keyboard & Mouse



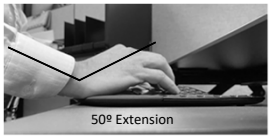
Traditional keyboard

Fixed split keyboard

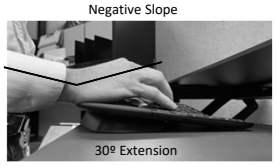
## Keyboard Slope

Positive Slope


Flat




Negative Slope




- Standing workstation
- Fixed height from floor

## Prototyping Additional Negative Slope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## Keyboard Width

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# Mouse Styles
(Forearm Rotation)

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# Sit/Stand Workstations

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# Styles of Sit/Stand Workstations

- Desk-top Convertible

- Convertible (powered and manual)

- Two-desk

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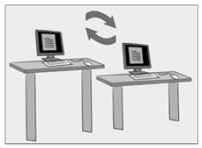
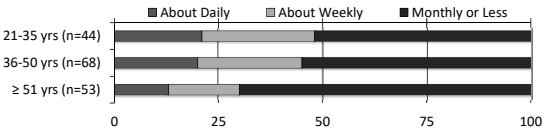
# Sit/Stand Workstations

- 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 [12]

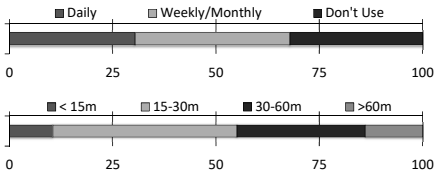



- Sit/Stand workstations appear to reduce sitting time by and average of 15 to 99 minutes [13]
  - Evidence is weak and based on studies of 3-12 months. No evidence of efficacy for longer durations


[12] Wilks et al., 2006. Appl. Ergon. 37, 359–365. DOI: 10.1016/j.apergo.2005.06.007

[13] Shrestha et al., 2018. Cochrane database Syst. Rev., CD010912. DOI: 10.1002/14651858.CD010912.pub5


# 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 (61-66%)
  - Discomfort (57-60%)
  - Felt tired (54-59%)


[14] Renaud et al., 2018. Int J Environ Res & Pub Health 15, 1 – 21. DOI: 10.3390/ijerph15092019

# 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]

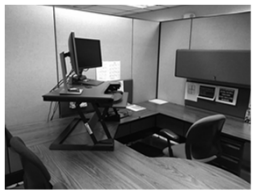

[15] Graves et al., 2015. BMC Public Health 15, 1145. DOI: 10.1186/s12889-015-2469-8

[16] Grunseit et al., 2013. BMC Public Health 13, 365. DOI: 10.1186/1471-2458-13-365

[17] Wilks et al., 2006. Appl. Ergon. 37, 359–365. DOI: 10.1016/j.apergo.2005.06.007




# Desk-Top Convertible



- Pros:
  - Inexpensive
  - Easy to deploy
- Cons:
  - Limited workspace
  - Difficult to adjust



# Desk-Top Convertible

- Watch for:
  - Stability/tipping
  - Lift/lower force
  - Lift range
- Sitting adjustment (too tall)?
- Sitting leg clearance

# Desk-Top Convertible

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# Motorized Convertible

- Pros:
  - Easy to adjust
  - Large workspace
- Cons:
  - Slow to adjust
  - Loud motors
  - Expensive

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# Motorized Convertible

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

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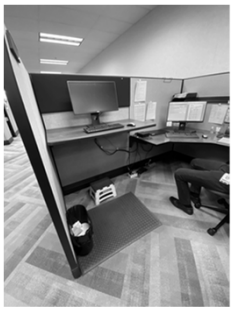
# Two-Desks

- Pros:
  - No adjustment
  - Large workspace
- Cons:
  - Extra equipment (cost)
  - Need more space



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## Two-Desk Approach — Fit


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# Two-Desk Sit-Stand Variant

Note: 4-8" Footstool

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## Setting Standing Height

Too Low | Good Height | Too High

Below Elbow ✘ | About at Elbow ✓ | Above Elbow ✘

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# Other Aspects

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## Multi-Focal Lenses

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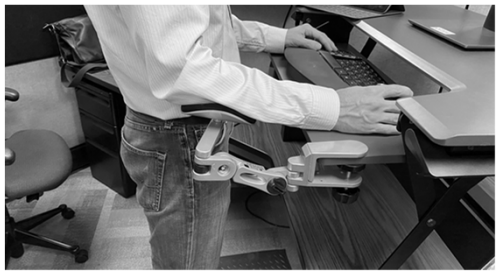
# Arm Support



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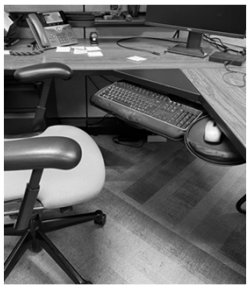
# Keyboard Tray



Advantage: Low keyboard height

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

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# Alternative Seating

- Note: Foot Support

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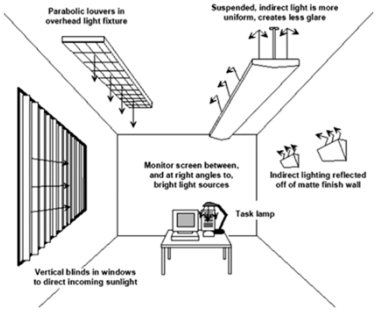
# Lighting Solutions




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


[1] Mediouni et al., 2014. JOEM. 56(2): 204-208. DOI: 10.1097/JOM.0000000000000080
[2] Gerr et al., 2002. Am J Ind Med, 41: 221-235. DOI: 10.1002/ajim.10066.
[3] Bergqvist et al. 1995. Ergonomics. 38: 754-62. DOI: 10.1080/00140139508925147
[4] Harris-Adamson et al. 2015. BMJ. 72: 33-41. DOI: 10.1136/oemed-2014-102378
[5] Garg et al. 2017. Ergonomics. 60(7): 912-922. DOI: 10.1080/00140139.2016.1237678
[6] Roffey et al. 2011. Spine J. 10(3): 252-61. DOI: 10.1016/j.spinee.2009.12.005
[7] Agarwal et al., 2018. Ergonomics. 61(4): 538-552. DOI: 10.1080/00140139.2017.1402960
[8] Nachemson, 1981. Spine, 6(1): 93-97. DOI: 10.1097/00007632-198101000-00020
[9] Andersson and Ortengren, 1974. Scand. J. Rehab. Med. 6(3): 115-121 PMID: 4417802
[10] Sheahan et al., 2016. Appl. Ergon. 53, 64–70. DOI: 10.1016/j.apergo.2015.08.013
[11] Marcus et al., 2002. Am. J. Ind. Med. 41, 236–249. DOI: 10.10002/ajim.10067
[12] Wilks et al., 2006. Appl. Ergon. 37, 359–365. DOI: 10.1016/j.apergo.2005.06.007
[13] Shrestha et al., 2018. Cochrane Database Syst. Rev., CD010912. DOI 10.1002/14651858.CD010912.pub5
[14] Renaud et al., 2018. Int J Environ Res & Pub Health 15, 1 – 21. DOI: 10.3390/ijerph15092019
[15] Graves et al., 2015. BMC Public Health 15, 1145. DOI: 10.1186/s12889-015-2469-8
[16] Grunseit et al., 2013. BMC Public Health 13, 365. DOI: 10.1186/1471-2458-13-365
[17] Wilks et al., 2006. Appl. Ergon. 37, 359–365. DOI: 10.1016/j.apergo.2005.06.007




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.