

Ergonomics and Upper Extremity Disorders Among Computer Users

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Two studies

- “The frequency of carpal tunnel syndrome in computer users is similar to that in the general population.”
□Stevens et al., 2001, Neurology, 56:1568-70.
- “More than 50% of computer users reported musculoskeletal symptoms during the first year after starting a new job.”
□Gerr et al., 2002, Am J Ind Med. 41:221-235

Hand and Arm

	At entry				During follow-up							
	N	Frequency	% of exams ^a	Prevalence (SE)	N	Frequency	% of exams ^a	Incidence rate (SE)				
								1 month	3 month	6 month	12 month	
Hand/arm symptoms	632	24	—	3.8 (0.8)	574	141	—	8.6 (1.3)	17.0 (1.9)	29.5 (2.8)	38.8 (3.3)	
Hand/arm disorders (total)	630	14	63.6	2.2 (0.6)	582	81	67.5	4.9 (1.0)	9.5 (1.4)	16.3 (2.0)	21.1 (2.5)	
Medial epicondylitis	630	1	4.5	0.2 (0.2)	582	5	4.2	0.6 (0.3)	0.6 (0.4)	1.0 (0.5)	1.4 (0.6)	
Lateral epicondylitis	630	3	13.6	0.5 (0.3)	582	14	11.7	1.1 (0.5)	1.7 (0.6)	2.8 (0.8)	3.5 (0.9)	
Flexor carpi radialis tendinitis	630	4	18.2	0.6 (0.3)	582	17	14.2	1.1 (0.5)	1.9 (0.6)	3.8 (0.9)	4.9 (1.2)	
Flexor carpi ulnaris tendinitis	630	3	13.6	0.5 (0.3)	582	10	8.3	0.8 (0.8)	1.3 (0.5)	2.2 (0.8)	2.9 (0.9)	
Digital flexor tendinitis	630	6	27.3	1.0 (0.4)	582	33	27.5	2.2 (0.7)	3.8 (0.9)	6.4 (1.3)	8.7 (1.6)	
Extensor tendinitis												
—Dorsal comp 1	630	8	36.4	1.3 (0.4)	582	56	46.7	3.6 (0.8)	6.8 (1.2)	11.2 (1.7)	14.7 (2.1)	
—Dorsal comp 2	630	5	22.7	0.8 (0.4)	582	22	18.3	1.5 (0.5)	2.5 (0.7)	5.1 (1.1)	5.8 (1.3)	
—Dorsal comp 3	630	0	0.0	0.0	582	0	0.0	—	—	—	—	
—Dorsal comp 4	630	4	18.2	0.6 (0.3)	582	16	13.3	1.1 (0.5)	2.1 (0.7)	3.6 (1.0)	4.6 (1.2)	
—Dorsal comp 5	630	2	9.1	0.3 (0.2)	582	9	7.5	0.8 (0.3)	1.5 (0.6)	2.3 (0.8)	2.8 (0.9)	
—Dorsal comp 6	630	4	18.2	0.6 (0.3)	582	12	10.0	0.8 (0.4)	1.9 (0.6)	2.8 (0.8)	3.5 (1.0)	
Intersection syndrome	630	0	0.0	0.0	582	1	0.8	—	—	—	—	
Trigger finger	630	0	0.0	0.0	582	4	3.3	0.4 (0.3)	0.6 (0.4)	1.0 (0.5)	1.2 (0.6)	
Carpal tunnel syndrome	630	3	13.6	0.5 (0.3)	582	3	2.5	0.2 (0.2)	0.6 (0.4)	0.8 (0.4)	0.9 (0.5)	
Ulnar neuritis	630	0	0.0	0.0	582	1	0.8	—	—	—	—	

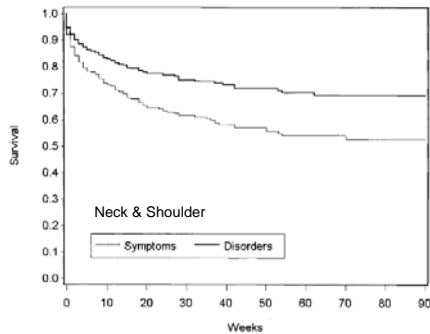
Gerr et al. (2002) Am J Ind Med. 41:221-235

Neck and Shoulder

	At entry				During follow-up							
	N	Frequency	% of exams ^a	Prevalence (SE)	N	Frequency	% of exams ^a	Incidence rate (SE)				
								1 month	3 month	6 month	12 month	
Neck/shoulder symptoms	632	63	—	10.0 (1.2)	538	163	—	17.8 (1.9)	32.1 (2.8)	48.1 (3.6)	57.5 (4.1)	
Neck/shoulder disorders (total)	622	37	69.8	5.9 (0.9)	554	117	72.6	10.8 (1.5)	19.7 (2.1)	28.7 (2.8)	35.0 (3.2)	
Radicular pain syndrome	622	1	1.9	0.2 (0.2)	554	6	3.7	0.6 (0.4)	1.2 (0.5)	1.7 (0.7)	1.9 (0.8)	
Somatic pain syndrome	622	36	67.9	5.8 (0.9)	554	111	68.9	10.6 (1.5)	19.0 (2.1)	27.6 (2.7)	33.2 (3.2)	
Rotator cuff tendinitis	622	3	5.7	0.5 (0.3)	554	7	4.3	0.2 (0.2)	0.9 (0.5)	1.4 (0.6)	2.2 (0.8)	
Bicipital tendinitis	622	1	1.9	0.2 (0.2)	554	3	1.9	0.0	0.2 (0.2)	0.6 (0.4)	0.9 (0.5)	

Gerr et al. (2002) Am J Ind Med. 41:221-235

Survival



Gerr et al. (2002) Am J Ind Med. 41:221-235

Physical Risk Factors: Upper extremity disorders

- Repetitive tasks
- Forceful tasks
- Combination of repetition and force
- Combination of repetition and cold
- Vibration



National Research Council/Institute of Medicine committee (2001) National Academy Press

Physical risk factors

Duration **Posture**

Force

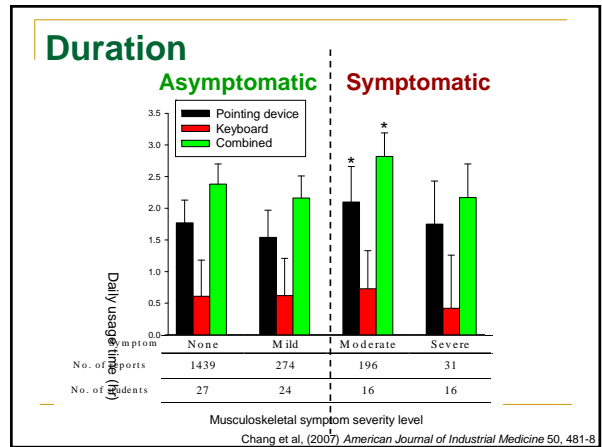
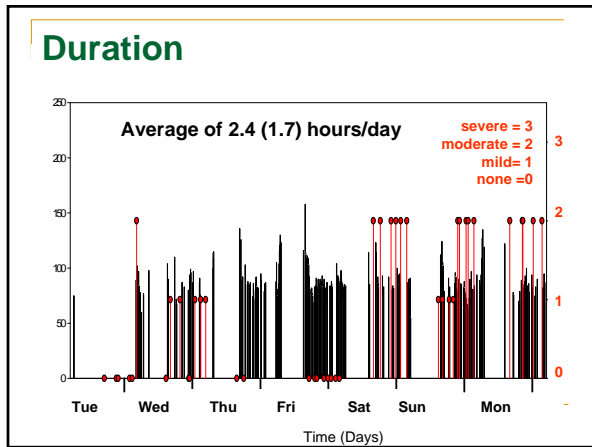
Gerr et al. (2004) *J Electromyogr Kinesiol* 14, 25-31

Duration

Daily Computer Usage Correlated With Undergraduate Students' Musculoskeletal Symptoms

Che-hsu (Joe) Chang, PT, MS,¹ Benjamin C. Amick III, PhD,^{2,3} Cammie Chaumont Menendez, MPH, MS,² Jeffrey N. Katz, MD, MS,^{1,4} Peter W. Johnson, PhD,⁵ Michelle Robertson, PhD,⁶ and Jack Tigh Dennerlein, PhD¹

Chang et al. (2007) *American Journal of Industrial Medicine* 50, 481-8



Posture

Keyboard Height above the elbow height

Gerr et al. (2004) *J Electromyogr Kinesiol* 14, 25-31

Posture

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 41:236-249 (2002)

A Prospective Study of Computer Users: II. Postural Risk Factors for Musculoskeletal Symptoms and Disorders

Michele Marcus, PhD,^{1,2*} Fredric Gerr, MD,² Carolyn Monteilh, PhD,² Daniel J. Ortiz, MPH,³ Eileen Gentry,⁴ Susan Cohen, MPH,² Alicia Edwards, MA,² Cindy Ensor, BS, OT/CHI,⁵ and David Kleinbaum, PhD¹

Latest Epidemiology

Protective

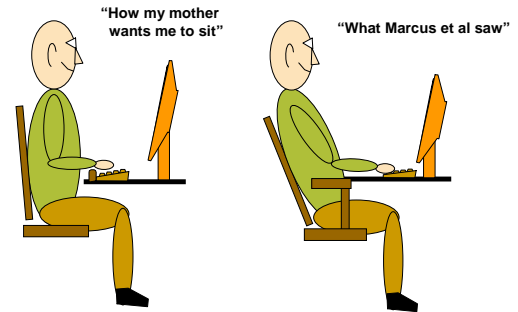
- **Neck and shoulder**
 - Elbow angle > 121°
 - Greater downward head tilt
 - Presence of Arm Rests
- **Hand and Arm**
 - Keyboard > 12cm away from the edge of table

Risks

- **Neck and shoulder**
 - Keyboard above elbow height
 - Telephone shoulder rest
- **Hand and Arm**
 - Keyboard height > 3.5 cm above the table height
 - Key activation force > 48 g
 - Radial wrist deviation > 5° with mouse use

Marcus et al. (2002) Am J Ind Med. 41:236-249

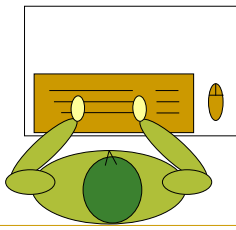
Posture



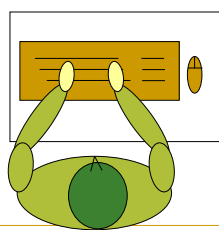
Marcus et al. (2002) Am J Ind Med. 41:236-249

- Less Ulnar Deviation
- Less internal rotation of shoulder
- Less abduction

NEAR



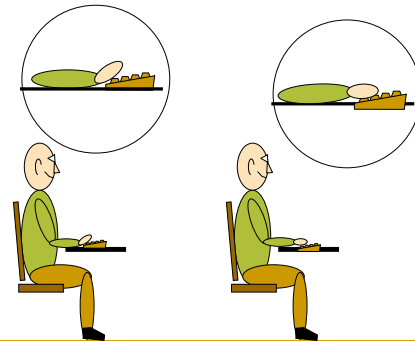
FAR



Kotoni et al. (2007) Ergonomics. 50, 1419-32

Posture

Keyboard height > 3.5 cm above the table height



Kotoni et al. (2007) Ergonomics. 50, 1419-32

Mismatch between worker and work station



Office Ergonomics

- Epidemiology
 - Outcomes
 - Identified Risk Factors
- Intervention Research
- Guidelines (Best Practices)
 - Desk tops
 - Notebook

Interventions

Amick BC, Kennedy CA, Dennerlein JT, Brewer S, Catli S, Williams R, Serra C, Gerr F, Irvin E, Mahood Q, Franzblau A, Van Eerd D, Evanoff B, Rempel D.

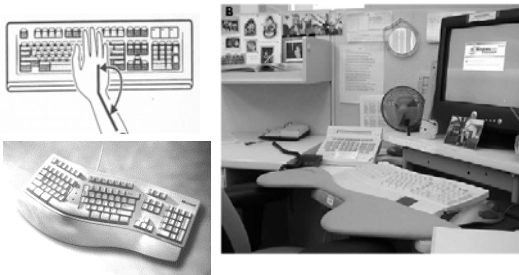
Systematic review of the role of occupational health and safety interventions in the prevention of upper extremity musculoskeletal symptoms, signs, disorders, injuries, claims and lost time. Toronto: Institute for Work & Health; 2008.

Interventions

	# Studies	Effect	Confidence
Workstation adjustments	4	-	strong
Training	4	+/-	mixed
Adjustments & training	1	+	limited
Alternative keyboards	2	+	limited
Alt. pointing devices	2	+/-	mixed
Arm supports	3	+	moderate
New chair	1	+	limited

Amick et al., 2008

Interventions (Posture & Support)



Rempel, et al (2006). *Occup Environ Med* 63, 300-6.
Dennerlein (2006) *Occupational Ergonomics*

Interventions

TAKING BREAKS

“Strategic rest breaks reduce VDT discomforts without impairing productivity, NIOSH study finds”

- Additional 20 minutes of breaks (5 min per hour)



Galinsky et al (2000) *Ergonomics* 43(5):622 - 638

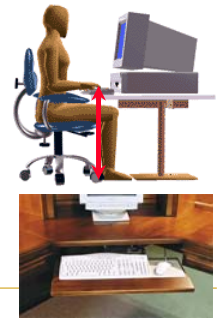
Best Practices

- Vision** → Body follows the eyes
- Reach** → Keep it close
- Support** → Allows for relaxation
- Drives to **neutral postures**



Best Practices: Work surface at elbow height

- Arms parallel to ground
 - g-h key height = elbow height
 - mouse and keyboard at the same height
- New furniture → Adjustable tables
- Retrofits → Keyboard trays



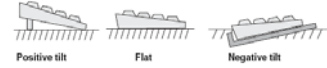
Chairs and foot rests

Promoting lumbar lordosis
Adjustable – height, depth
Avoid prolong sitting



Best Practices: Drive to neutral postures

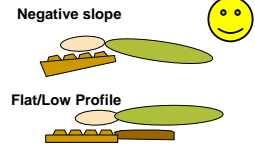
Slope/Tilt



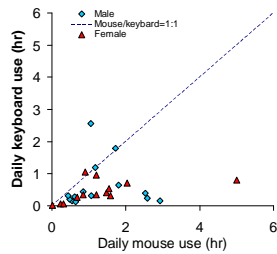
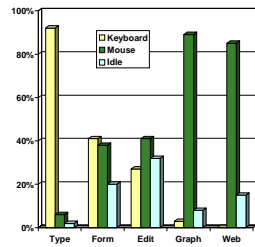
- Depends on elbow & visual access needs

Keep wrists straight or slightly flexed

- Low profile keyboards or raised surface



Mouse or Keyboard



Dennerlein and Johnson. (2006) *Ergonomics* 49:45-61
 Chang et al (2007) *Am. J. Ind. Med.* 50:481-8

Horizontal Flexibility



Keyboard:

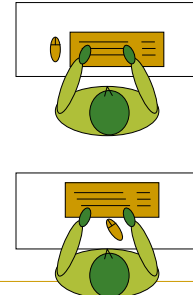
- Directly in front of worker,
- further away is better

Mouse:

- right or left
- directly in front (mouse intensive tasks)

Trays limit horizontal

- Place for mouse



Dennerlein and Johnson (2006) *Ergonomics*, 49:1456-69

Speech recognition

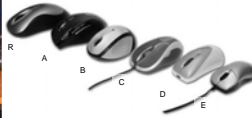
- n Good alternative for physically and/or visually challenged persons, persons with advanced disorders (Prevention)
- n Performance varies widely but improving
- n May not be suitable for highly interactive tasks (e.g. multi-software, web-browsing, etc.)



Laptops



Laptops



Sommerich et al. (2002) *Int J. Ind Ergo*, 30, 7-31.
Oude Hengel et al. (2008) *Clin. Biomech* 2008; 23:727-34.

In conclusion

- MSDs are typical among office workers
- Epidemiological literature identified
 - Duration / Posture / Force
- Interventions
 - Integration of workstation adjustments and training
 - Alternative devices, arms rests and chairs improve conditions.

