

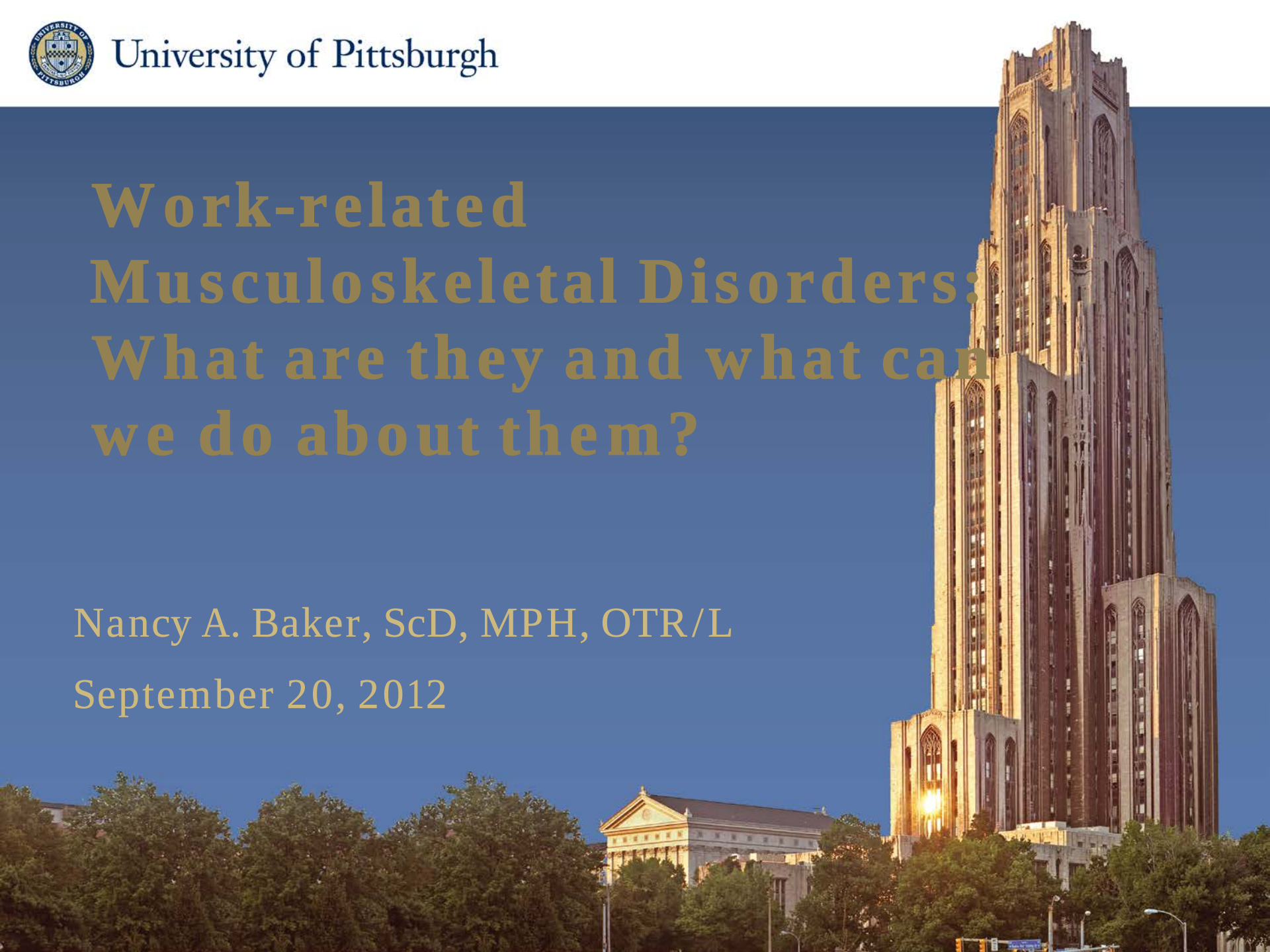


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Work-related Musculoskeletal Disorders: What are they and what can we do about them?

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September 20, 2012





Agenda

- Musculoskeletal Disorders (MSD)
- Biomechanical Risk Factors for MSD
- My research on MSD and computer use
 - Measuring Risk Factors for Computer Users
 - Measuring Pain as an outcome measure
 - Computer Workstation Design



Occupational Biomechanics

- “Uses laws of physics and engineering concepts to describe motion undergone by the various body segments and the forces acting on these body parts during normal activities”
(p. 1)
- Goal – Improved performance and reduced risk of mechanical trauma



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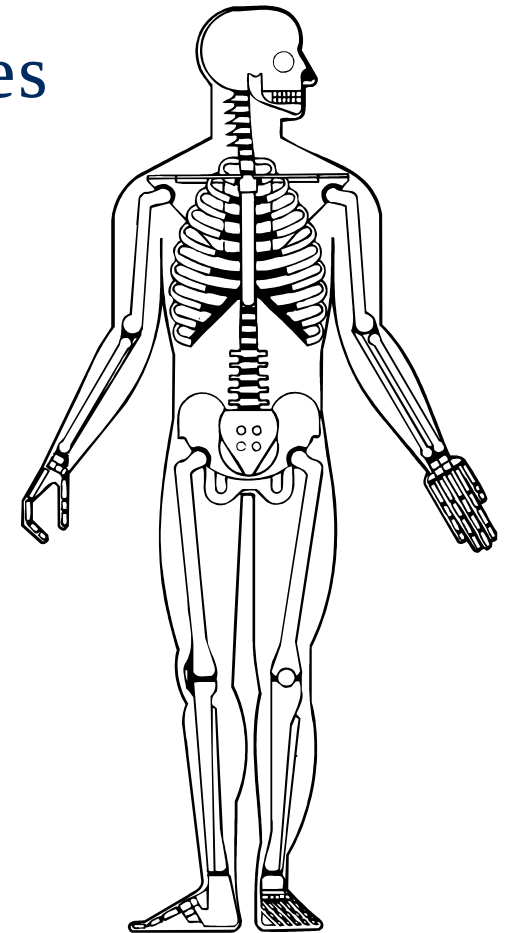
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Musculoskeletal Disorders of the Upper Extremity



Musculoskeletal Disorders (MSD)

“Umbrella Term” describing illnesses of the muscles, tendons, nerves, and bone that are not caused by a specific trauma, but occur gradually over time and are probably due to a combination of physical, emotional, and organizational factors



Injury mechanisms

Event

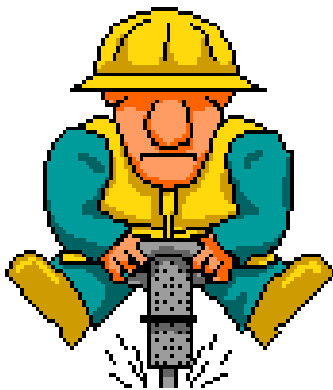
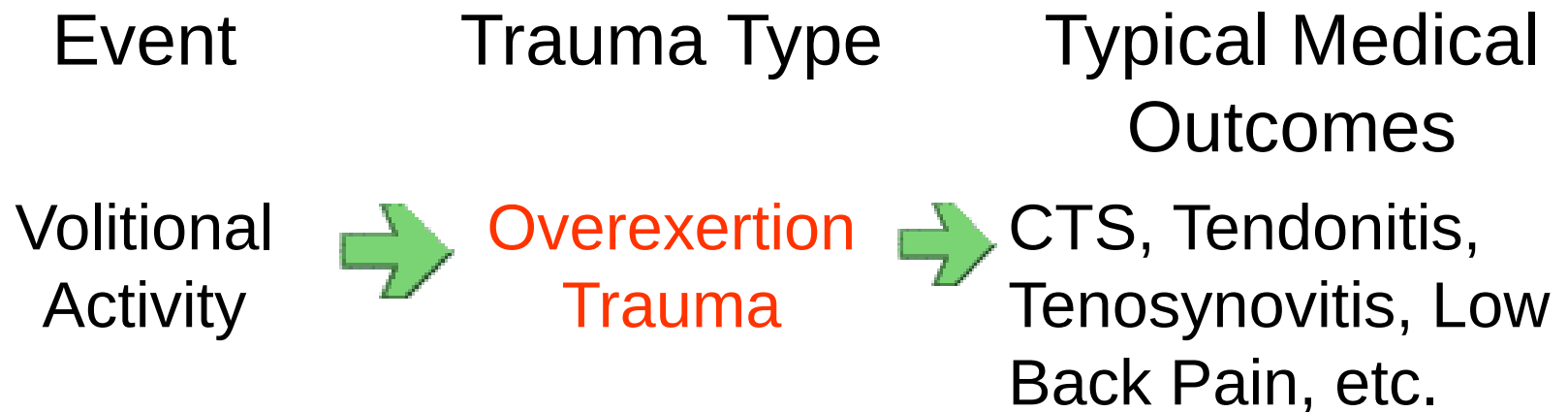
Trauma Type

Typical Medical Outcomes

Sudden Force → **Impact Trauma** → Contusions, Lacerations, Fractures, Amputations, etc.

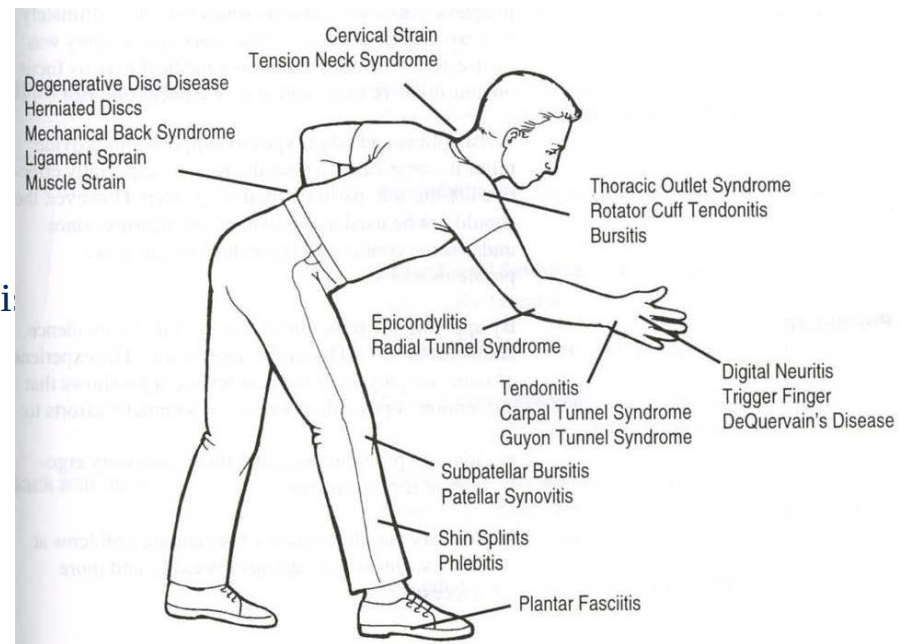


Injury mechanisms



Structures affected in MSD

- Joint/joint capsule
 - osteoarthritis, bursitis, synovitis, adhesive capsulitis
- Muscles
 - focal dystonia, fibromyositis, myalgia
- Tendons
 - strains, tendonitis, tenosynovitis, epicondylitis
- Peripheral nerves
 - CTS, Guyon tunnel, Sciatica
- Neurovascular/vascular
 - Raynaud's syndrome
- Disc
 - bulge, herniation





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Biomechanical Risk Factors

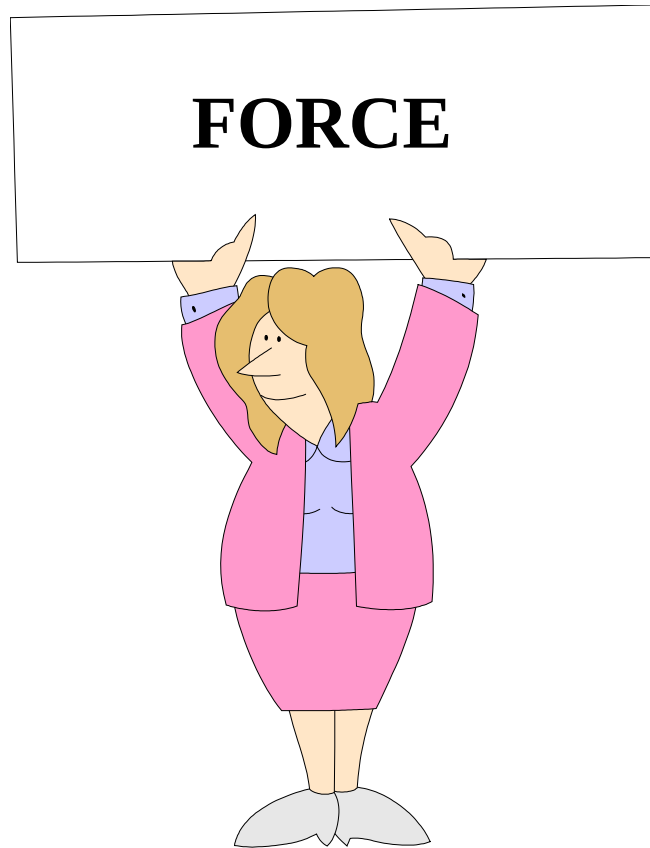


Biomechanical Risk Factors

- Force
- Awkward Posture
- Repetition
- Static Posture



Biomechanical Risk Factors

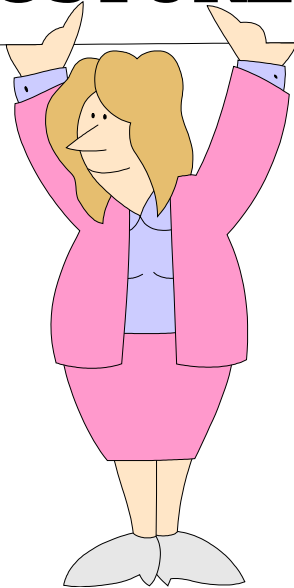


- Muscle contractions exceeding 8% of MVC
- Reduces blood supply to muscles, tendons and nerves
- Tensile stress on attachments
- Examples
 - Gripping instruments



Biomechanical Risk Factors

AWKWARD POSTURE

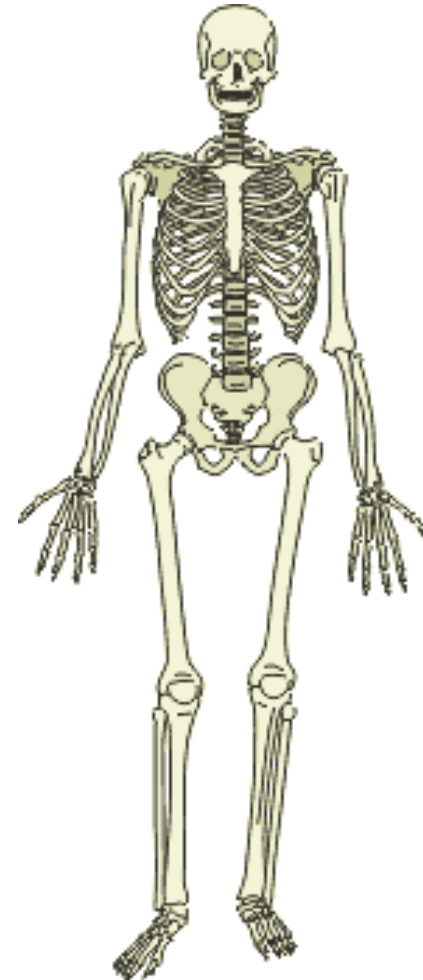


- Movements away from anatomical postures
- Decreased mechanical advantage
- Increased muscle contractions
- Stress/friction on muscles, tendons nerves, discs
- Examples
 - Bending over
 - Reaching overhead



Anatomical posture

- Eyes forward
- Arms at side
- Palms forward
- Toes forward





Biomechanical Risk Factors

REPETITION

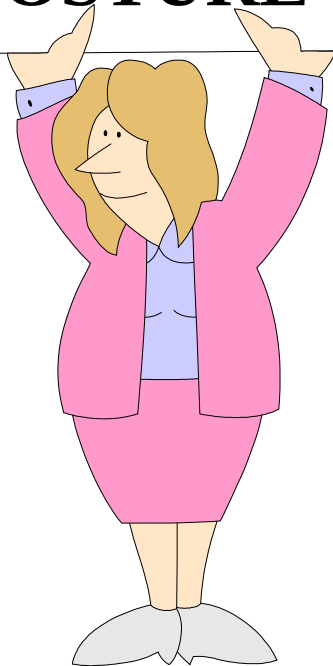
A cartoon illustration of a woman with blonde hair, wearing a pink blazer over a light blue top and a pink skirt. She is holding a large white rectangular sign above her head with both hands. The sign has the word "REPETITION" written on it in bold, black, uppercase letters.

- Repeated movements
- Increased friction on tendons, nerve muscles and bones
- Reduced rest/healing time
- Example:
 - Wrist, hand & finger movements exceeding 30 movements per minute
 - Similar movements in different tasks



Biomechanical Risk Factors

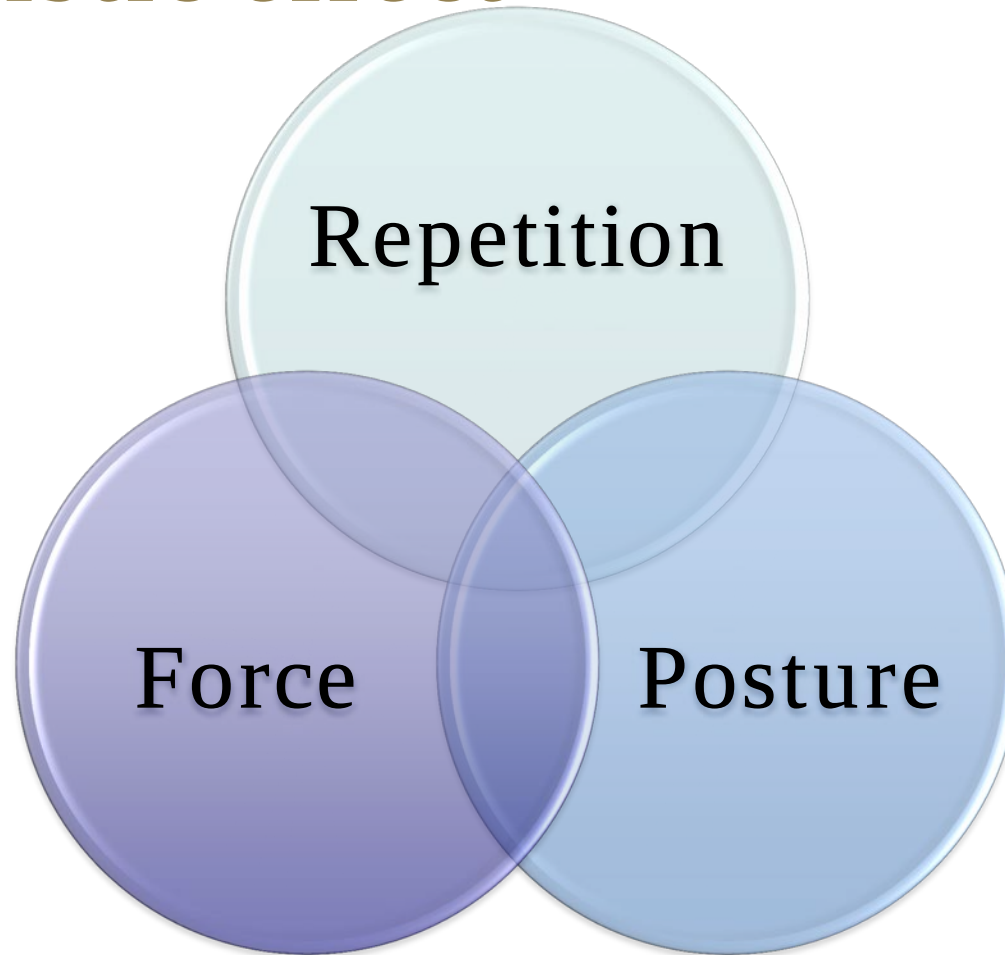
STATIC POSTURE



- Remaining in one posture for more than a few minutes
- Constriction of blood supply
- Decreased rest time
- Examples
 - Holding objects
 - Sitting

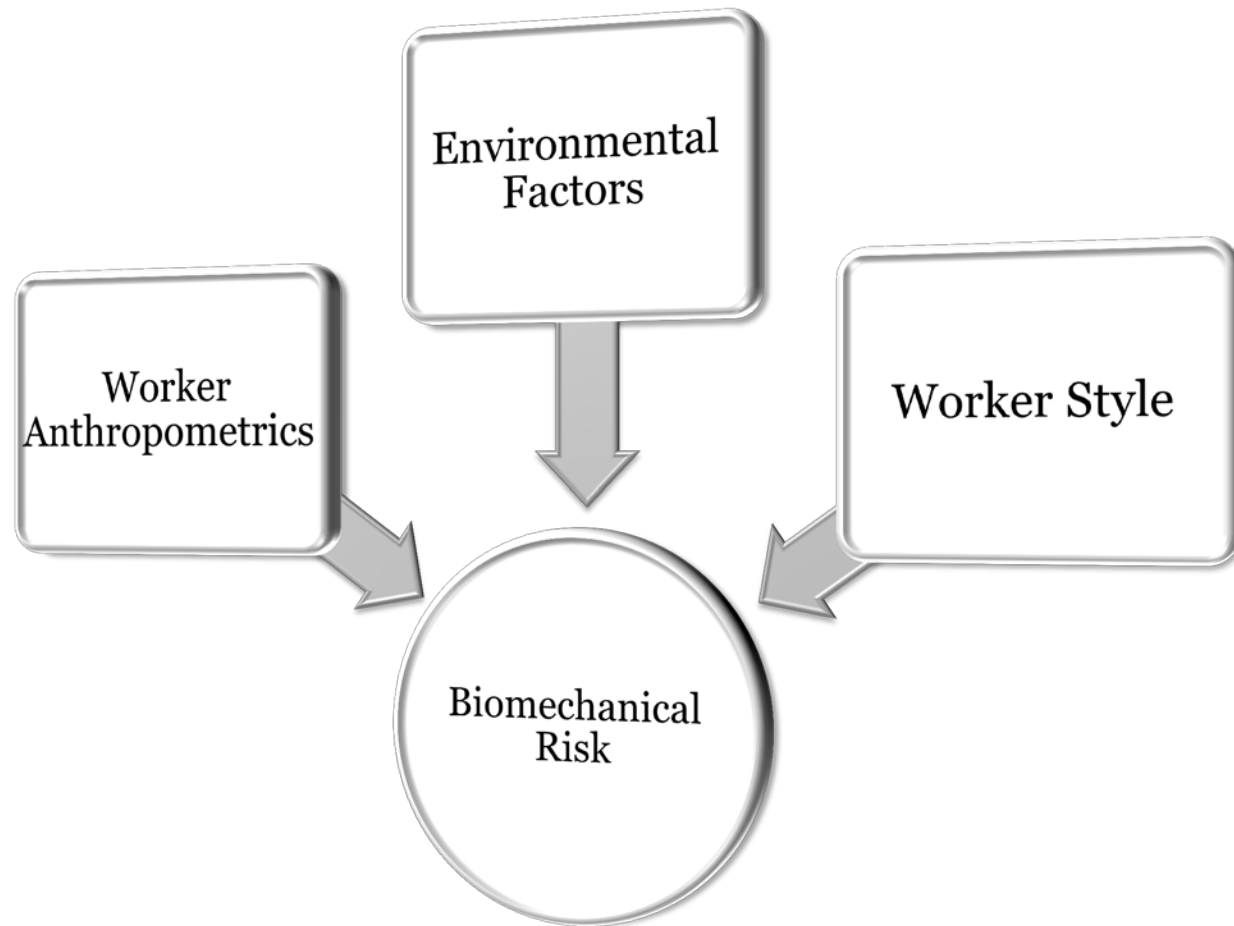


Synergistic effect





Biomechanical Risk Factors





MEASURING RISK FACTORS FOR COMPUTER USERS



Computer Use and MSD-UE

- More than 50% of the US working population uses a computer (*BLS, 2005*)
- The incidence of MSD-UE related injuries in computer users is 20% (*Gerr et al., 2002*)



Repetition

- 16,000 keystrokes per hour in skilled typists (*Hales et al., 1994*)
- Duration – 4 hours or more per day (*Brewer, et al., 2006*)



Force

- Keystroke forces are usually 2.4 to 7 times higher than necessary (*Martin et al., 1996; Sommerich et al., 1996*)
- ↑ force associated w/ ↑ carpal tunnel pressure (*Rempel et al., 1997*)
- ↑ force associated w/ ↑ discomfort (*Feuerstein et al., 1997*)
- Those w/ MSD-UE tend to strike keys harder (*Pascarelli & Kella, 1993*)



Awkward Postures

- Hypothesized to increase shear and friction, and carpal tunnel pressure (*Armstrong et al., 1984; Goldstein et al., 1987*)
- Risky postures
 - Neck flexion >30 degrees (*McAtamney & Corlett, 1993*)
 - Elbow flexion > 120 and <80 degrees (*Marcus et al., 2002*)
 - Forearm pronation greater than 80 degrees (*Zecevic et al., 2000*)
 - Wrist extension and/or wrist ulnar deviation > 20° (*Demure et al., 2000; Hunting et al., 1981*)
 - Awkward finger postures (*Pascarelli & Kella, 1993*)



Static Postures

- Computer use causes static loading of the neck and forearm muscles (*Aarås et al., 1998; Lin et al., 2004; Kleine et al., 1999*)
- Static loading has been associated with pain and MSD-UE (*Knardahl, 2002; Sjøgaard et al., 2000*)

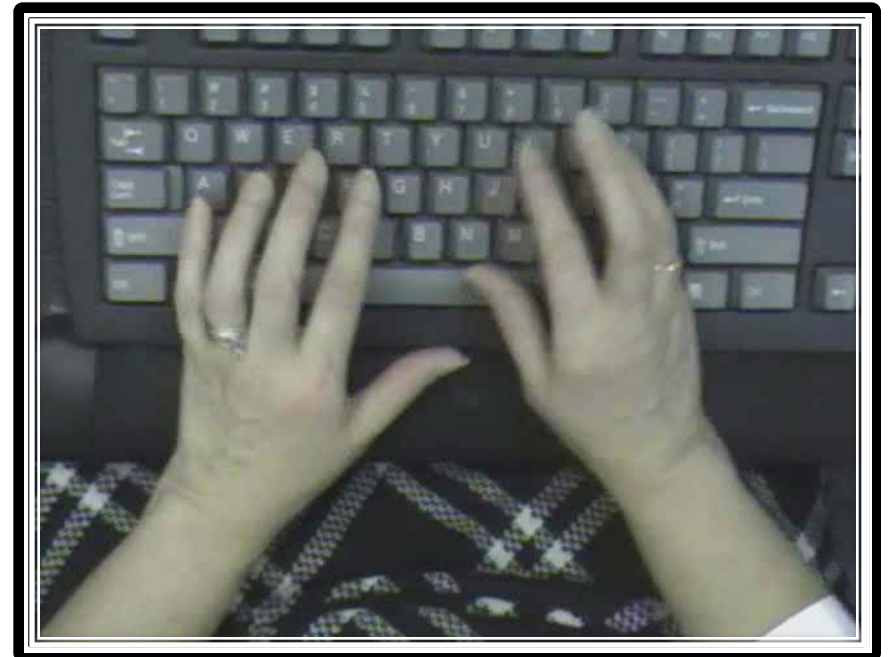


Personal Computer Style

- “an individual pattern of cognitions, behaviors, and psychological reactivity that co-occur while performing job tasks” (*Feurestein, p. 179*).
- Highly variable between individuals (*Sommerich, 1996; Baker, 2006*)
- Stereotypical within individuals (*Ortiz, et al.1997; Baker et al., 2006*)
- Association between personal workstyle and MSD-UE (*Pascarelli et al.,1993; Kilbom et al., 1987; Armstrong et al., 1999; Feuerstein et al., 1992*)



Personal Computer Styles



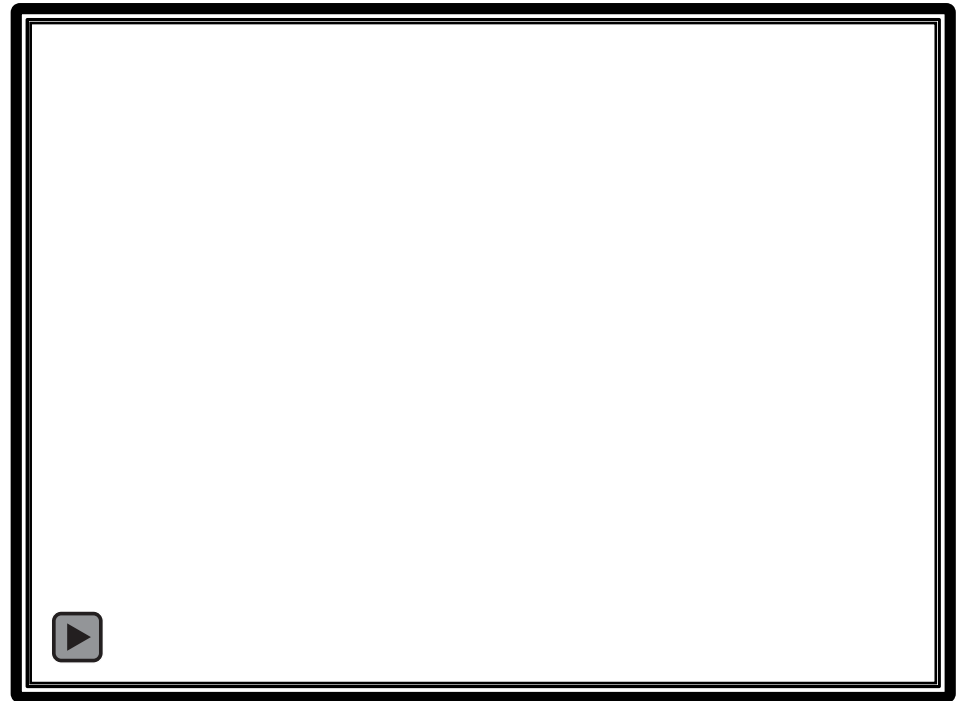


Measuring Typing Style

- Direct measurement
 - sonar device, electric goniometer, LED, electrode, force plates, video analysis systems, EMG
 - Pros – Very precise, very detailed
- Observational measurement
 - Criterion based checklist
 - Pros – quick, minimal equipment, clinically relevant



Measuring Risk - Lab





Measuring Risk - Workplace

- Uncontrolled environment
- Multiple jobs with multiple tasks
- Instrumentation
- Worksite culture



Measuring Risk - Workplace

- Observational Instruments
 - RULA - <http://www.rula.co.uk/survey.html>
 - NIOSH lifting equation - http://www.ccohs.ca/oshanswers/ergonomics/niosh/calculating_rwl.html
 - Strain Index - <http://personal.health.usf.edu/tbernard/HollowHills/StrainIndexM12.pdf>



K-PeCS

- 19-Item Criterion-Based Observation Tool
 - Three domains
 - Static body postures
 - Dynamic postures (frequency)
 - Tension and force
 - Ordinal or categorical scaling
 - “yes/no”
 - Frequency ratings (never, occasionally, frequently, constantly)
 - Ranges of postures (e.g. shoulder flexion angle = $0-20^{\circ}$; $21^{\circ}-35^{\circ}$; $>35^{\circ}$)



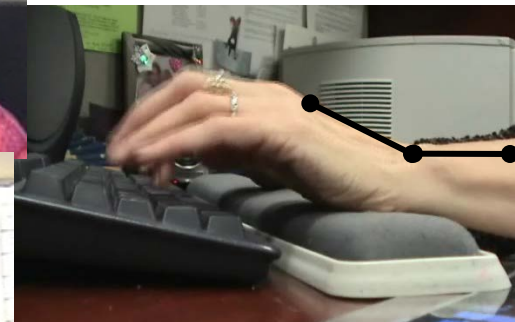
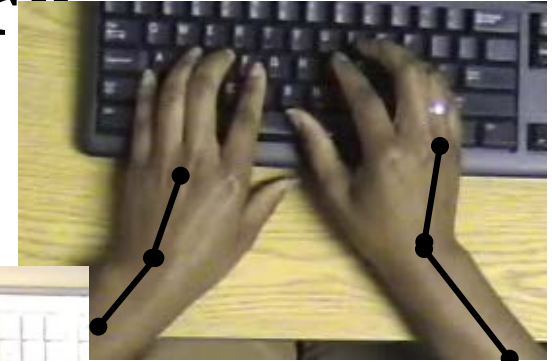
Items of Static Body Posture

- Angular position
 - Torso Angle
 - Neck Flexion Angle
 - Shoulder Flexion Angle
 - Elbow Flexion Angle



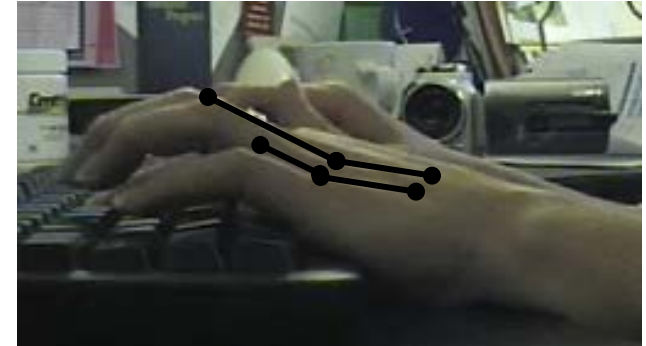
Items of Dynamic Posture

- Frequency/Presence of:
 - Wrist/Hand Displacement
 - Wrist Ulnar Angle
 - Wrist Extension Angle
 - Forearm Rotation



Items of Dynamic Posture

- Frequency/Presence of:
 - Isolated 1st Digit
 - Isolated 5th Digit
 - # of Digits to Type
 - Space Bar Activation
 - MCP Hyperextension
 - PIP/DIP Curve
 - DIP Hypermobility





Items of Tension and Force

- Support Use
 - Back Rest Use
 - Wrist Rest Use
 - Forearm Support
- Force





Measuring Risk Factors - Challenges

- Increasing Precision
- Reducing time to evaluate
- Associating Pain/risk factors
- Developing models of injury

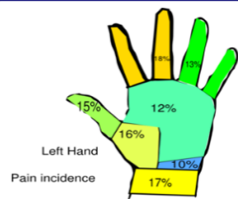


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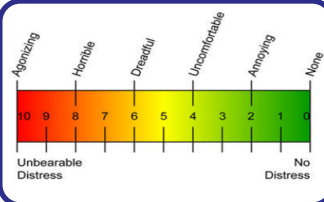
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Measuring Pain

Measuring Pain



Incidence



Severity



Quality

- Type of Discomfort
- Effect on person's life

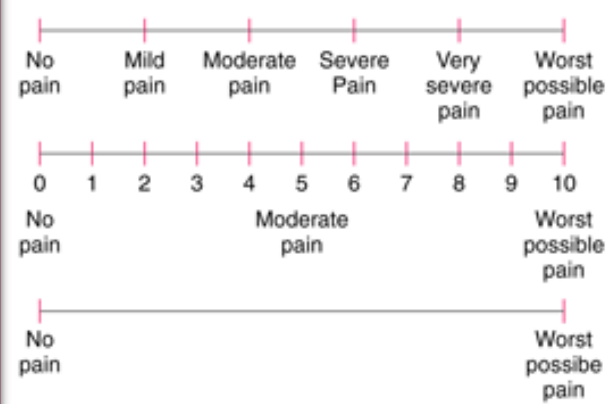


Measuring Pain - Incidence

- How often experience pain during a time period
- How long the pain lasts



Measuring Pain - Severity

Visual Analog Scale	Word Descriptor Scale
	0 = No pain 1 = Mild pain 2 = Distressing pain 3 = Severe pain 4 = Horrible pain 5 = Excruciating pain
Graphic Scale	Verbal Scale
	"On a scale of 0 to 10, with 0 meaning no pain and 10 meaning the worst pain you can imagine, how much pain are you having now?"
Functional Pain Scale	
0 = No pain 1 = Tolerable and pain does not prevent any activities 2 = Tolerable and pain prevents some activities 3 = Intolerable and pain does not prevent use of telephone, TV viewing, or reading. 4 = Intolerable and pain prevents use of telephone, TV viewing, or reading. 5 = Intolerable and pain prevents verbal communication	



Measuring Pain - Quality

What type of discomfort do you have

Pain

Cold

Numbness

Tingling

Aching

Burning

Circle the words that describe your pain.

aching

sharp

penetrating

throbbing

tender

nagging

shooting

burning

numb

stabbing

exhausting

miserable

gnawing

tiring

unbearable



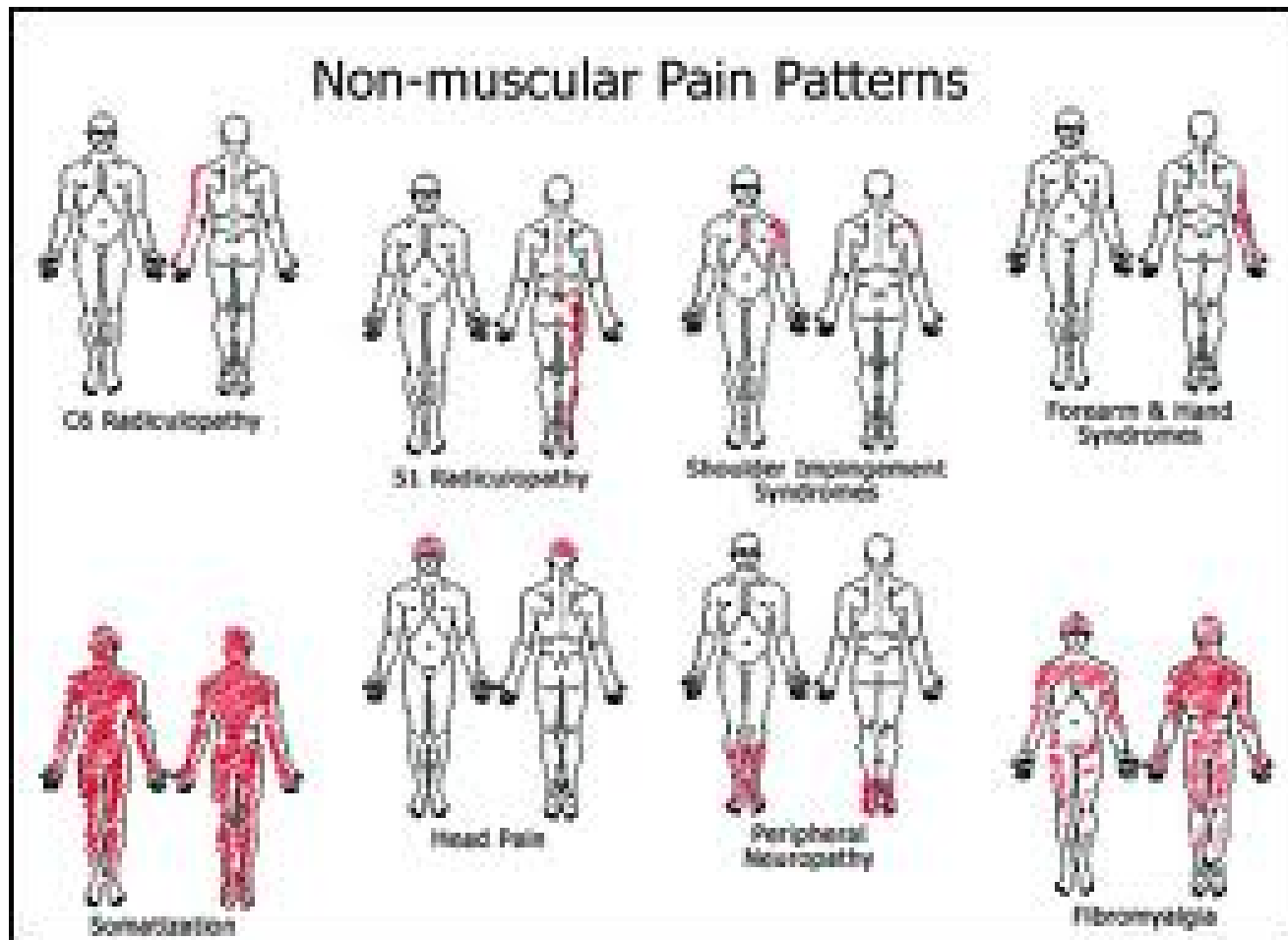
Measuring Pain - Quality

I. Circle the one number that describes how during the past week pain has interfered with your:

a. General Activity	Does Not Interfere	0 1 2 3 4 5 6 7 8 9 10	Completely Interferes
b. Mood	Does Not Interfere	0 1 2 3 4 5 6 7 8 9 10	Completely Interferes
c. Normal Work	Does Not Interfere	0 1 2 3 4 5 6 7 8 9 10	Completely Interferes
d. Sleep	Does Not Interfere	0 1 2 3 4 5 6 7 8 9 10	Completely Interferes
e. Enjoyment of Life	Does Not Interfere	0 1 2 3 4 5 6 7 8 9 10	Completely Interferes
f. Ability to Concentrate	Does Not Interfere	0 1 2 3 4 5 6 7 8 9 10	Completely Interferes
g. Relations with Other People	Does Not Interfere	0 1 2 3 4 5 6 7 8 9 10	Completely Interferes



Measuring Pain - Quality





Measuring Pain - Challenges

- Purely subjective
- Fluctuates
 - Severity/Frequency
 - Stable Baseline
- Effected by reporting
- Matching pain to action in MSD
- How much pain = MSD



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COMPUTER WORKSTATION DESIGN



Ergonomics

- “Fitting the job to the person
- Ensuring the job environment (physical, cognitive, psychosocial) matches the skills of the person completing the job
- Believe to reduce work stress (physical and mental)



Workstation Set-up

- Computer operators workstations are often poorly configured to match their needs
- Research supports reconfiguration combined with education to improve musculoskeletal health (*Goodman et al., 2012, Kennedy et al. 2009*)



Workstation Set-up - Challenges

- Measuring the worker in the workstation
 - Dynamic rather than static
 - “Tele-ergonomics”
 - Identifying where to intervene



Equipment - Challenges

- Education
 - Educate workers on how to adjust workstation
 - Educate workers about available equipment
 - Educate workers how to adjust their existing equipment
- Developing intuitive adjustable designs

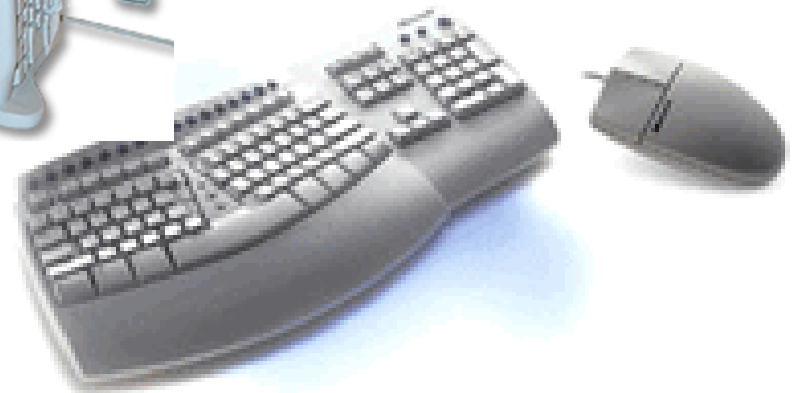
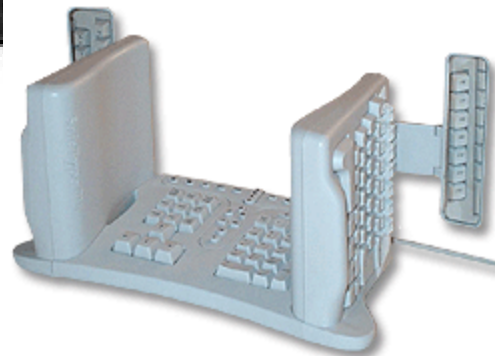
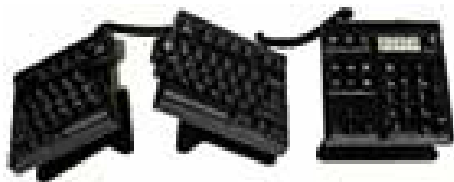
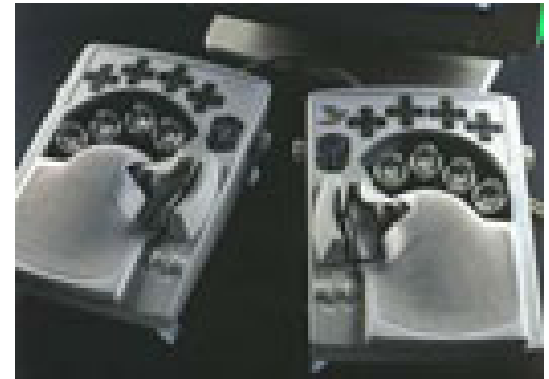


Input Devices

- “Ergonomic” keyboards and “mice”
 - Research suggests that they reduce “risky” postures” (*Baker and Cidboy, 2006*)
 - Research questionable whether they reduce discomfort (*Brewer et al., 2006; Kennedy et al., 2010*)



Alternative Keyboards





Input Devices





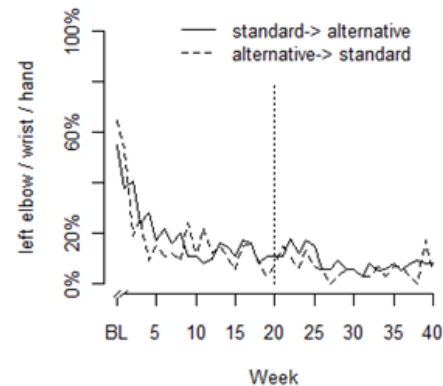
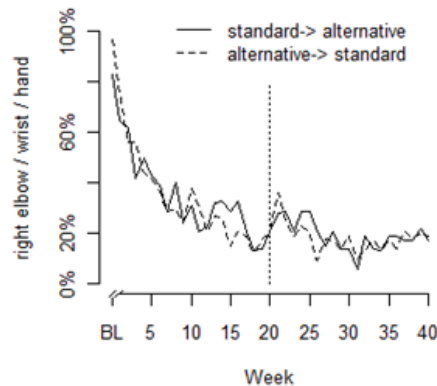
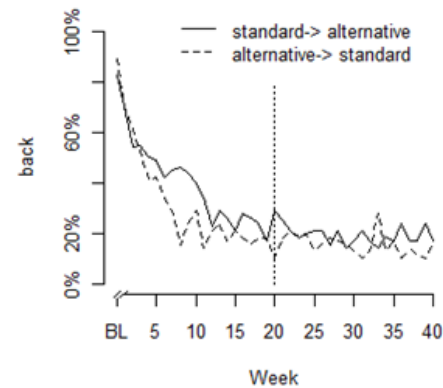
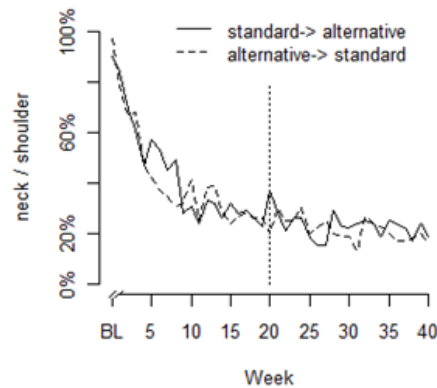
Alternate Keyboard

- RCT cross-over design
- 85 subjects with MSS received both alternate keyboard and standard keyboard for 5 months (random order)
- 77 subjects remained in study after 1 year





Results



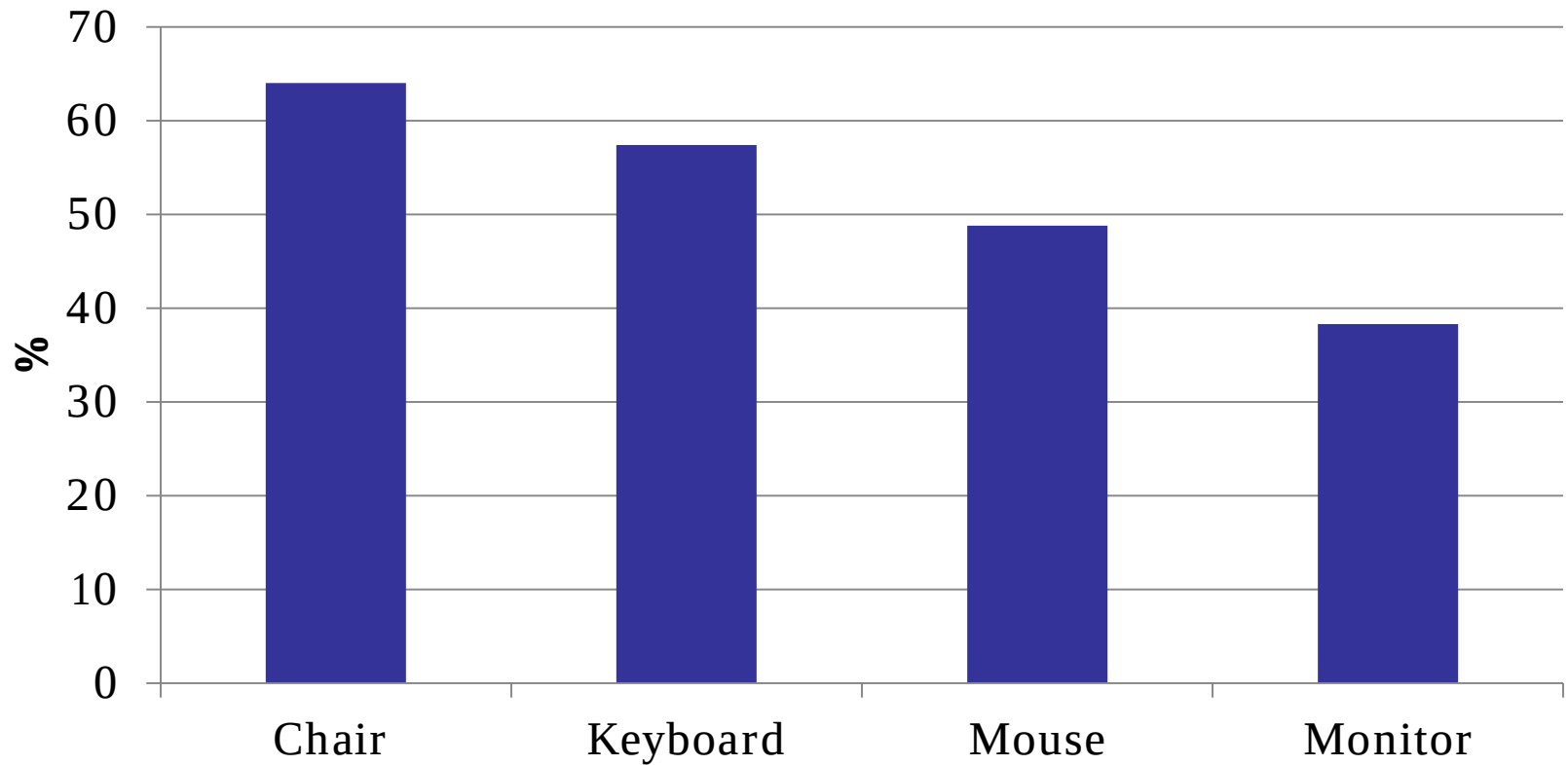


Input Devices - Challenges

- Determine which (if any) reduce discomfort/MSD
- Which design is most usable
- Design other input methods



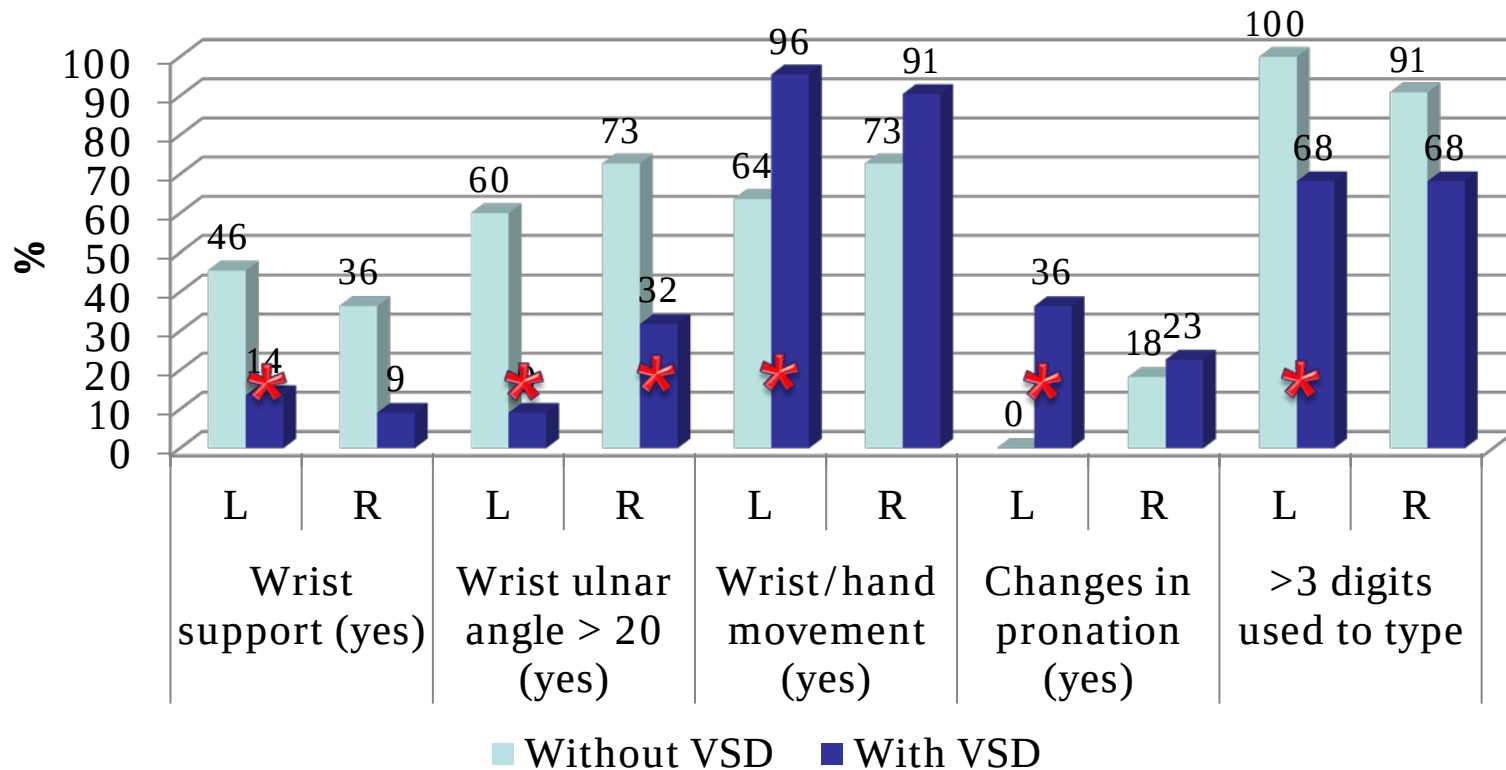
RA and Computer Use



Baker et al., 2012



Effect of structural changes on typing style





Users with Impairments - Challenges

- Which design is most usable and under what conditions
- What are alternate methods to input data?
- What are the best methods to measure performance?



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OTHER IDEAS?