

Work-related musculoskeletal disorders: The epidemiologic evidence and the debate

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What is a Musculoskeletal Disorder?

- Soft tissue pain, functional impairment and/or diagnosable condition
- Affecting muscle, tendon, peripheral nerve, joint, and/or circulatory tissues

Magnitude

- ~1,000,000 people lose work time annually due to MSDs in the U.S.
- Low back pain affects 30% of all European workers [TUTB 2000]
- About 1/3 of all U.S. lost-time work-related injuries and illnesses are disorders related to overexertion or repetitive motion [BLS]
- \$50 billion annually in work related costs

**Musculoskeletal Disorders
and The Workplace:
Low Back and Upper Extremities**

**Panel on Musculoskeletal Disorders
and the Workplace,
National Research Council
and
Institute of Medicine
2001**

**Charge included: “Evaluate contribution of
jobs and job tasks” “to the occurrence
of musculoskeletal disorders”**

When is an “association”
evidence of cause and effect?

Step 1: Interpretation of
individual studies

Are there alternative explanations
for the study findings?

(e.g., bias or confounding)

Step 2. “Patterns of Evidence”

Is there consistency across
different types of research?

Is there biological plausibility?

- Epidemiology
- Ergonomics, Biomechanics
- Physiology, Tissue mechanobiology
- Field experience of “best practices”

The Debate: High Background Rate of MSDs

- Common in the general population
- Multifactorial etiology
- What proportion is work-related?
- Not everyone exposed (at work) is affected

MSD Risk Factors in the General Population

There are many risk factors; the
presence of one does not negate another

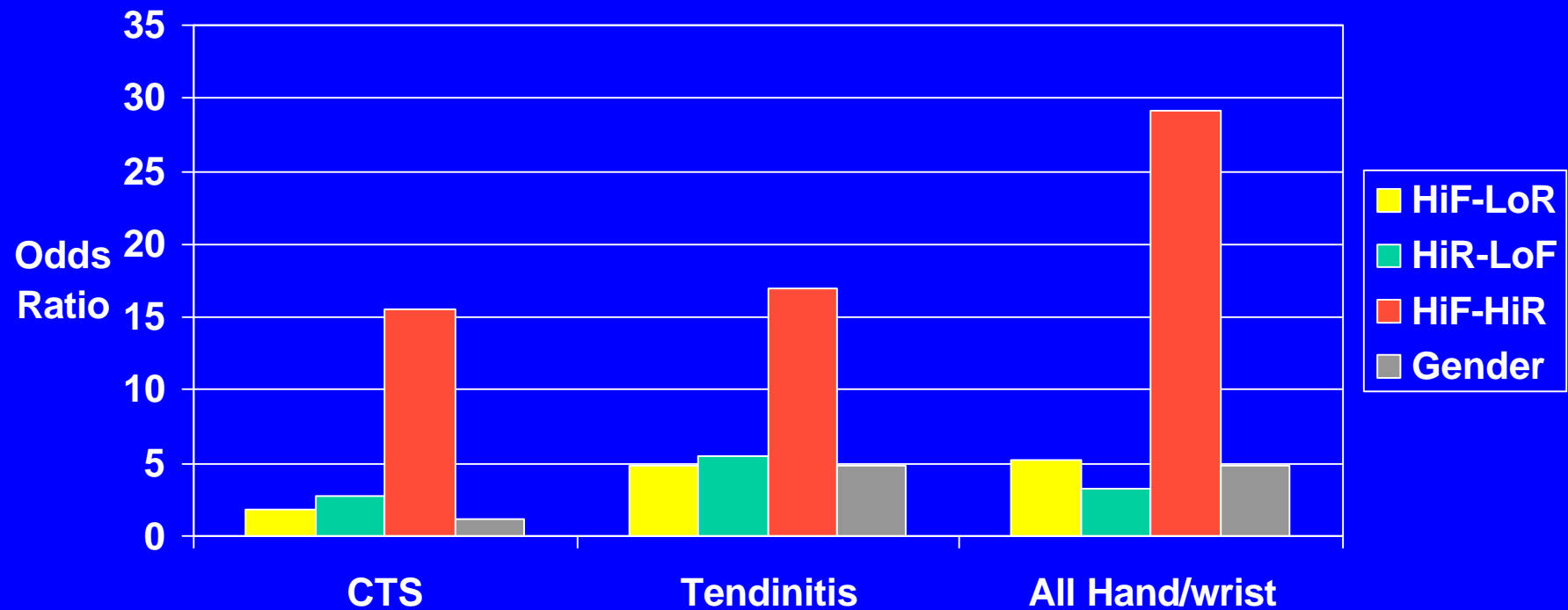
Workplace Factors

- Physical loads
- Organizational factors
- Social context

Individual Factors

- Physical characteristics
- Psychological factors
- Physical activities outside work

Occupational Factors and Disorders of the Hand/Wrist Region (Silverstein, Fine, Armstrong, 1986-87)



N.B. Crude effect of gender for all H/W disorders.
Analyses also adjusted for age, years on the job, and facility.

The Debate: MSD Case Identification

Limitations of diagnostic technologies

Symptoms range from specific to non-specific

Occurrence vs. reporting:

- Physiology (pain thresholds)
- Cultural differences
- Psychosocial effects
- Labor relations

Types of Outcome Measures

Self-Reported Symptoms

Presence

Severity

Disability

Self-Reported Work Status

Sick days

Return to work

Clinical Evaluation

Visit only

Physical exam

Tests

Administrative Records

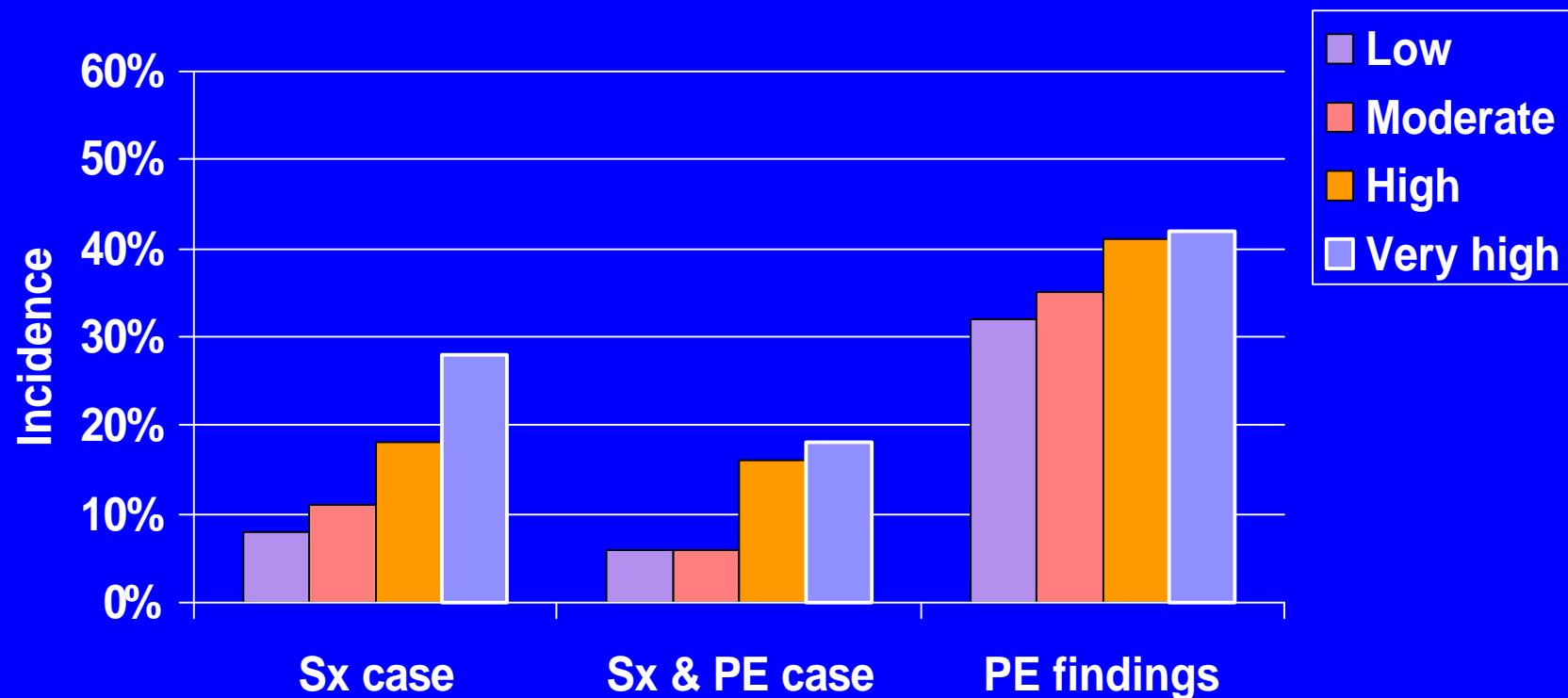
Compensation claim

Sick days

Return to work

(NRC/IOM, 2001)

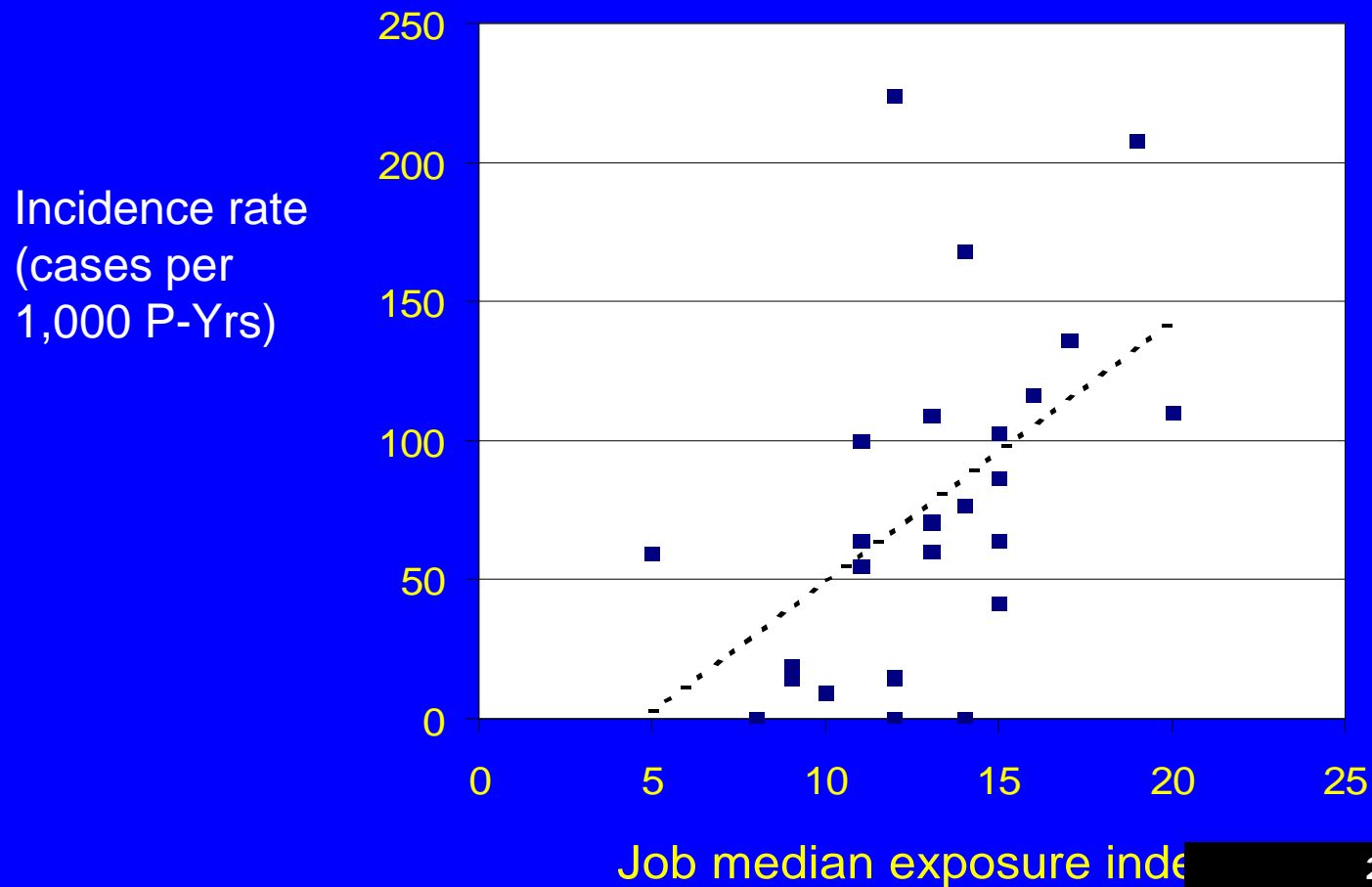
One-year cumulative incidence of UE disorders, by baseline index of combined exposures (automobile manufacturing workers: same job at follow-up)



Punnett et al.

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Incidence rates of medical visits for all MSDs, by ergonomic exposure index (automobile manufacturing)



Odds ratios for effects of hand-held vibrating tools: high lifetime dose (Bovenzi, 1994)

Upper limb pain	3.2	(1.9-5.2)
Dupuytren's contracture	3.2	(1.4-7.4)
CTS (symptoms & PE)	3.2	(1.2-8.7)
HAV sensorineural disturbance	4.7	(2.8-7.8)
Muscular weakness	14.7	(3.3-66.6)
VIWF symptoms	27.3	(13.1-56.6)

The Debate: Lack of Standardized Exposure Assessment Metrics

- Affects comparability of findings across studies
- Population-specific cut-points between “low” and “high” affect utility for determining exposure-response curves

Intensity of manual material handling associated with elevated risk of low back disorders

- > 10 kg frequent vs none (Magnusson 1996)
- > 10 kg daily (Alcouffe 1999)
- > 50 lb. frequently (Liira 1996)
- > 18 kg (Nuwayhid 1993)
- > 1 on NIOSH lifting index (Waters 1999)
- Lift 1 pt or transfer 5 pts/shift (Smedley 1997)
- Heavy load “all the time” vs seldom (Xu 1997)

Whole-body vibration dose associated with elevated risk of low back disorders

$a_z > 0.3, 0.4, 0.5 \text{ m/s}^2$	(Boshuizen 1990a,b,1992)
$a_z > 0.5, 0.6 \text{ m/s}^2$	(Bovenzi 1992, 1994)
> 4 h/day vs never	(Alcouffe 1999)
> 20 h/wk vs <10 h/wk	(Pietri 1992; Chiang 1993)
All the time vs seldom	(Xu 1997)
Any vs none	(Liira 1996; Magnusson 1996; etc.)

Daily duration of non-neutral posture associated with elevated risk of shoulder disorders

> 4 hrs/day (Holmstrom 1992)

> 2 hrs/day

or > 1/min (English 1995)

> 45/hr > 60 deg (Ohlsson 1995)

> 1/min > 90 degrees (Punnett 2000)

The Debate: Validity of self-reported ergonomic exposures

- Misclassification occurs with any exposure measure
- Little evidence of systematic bias
- Self-report of other epi. risk factors (e.g., cigarette smoking) universally accepted

The Debate: Partitioning risk among (related) exposures

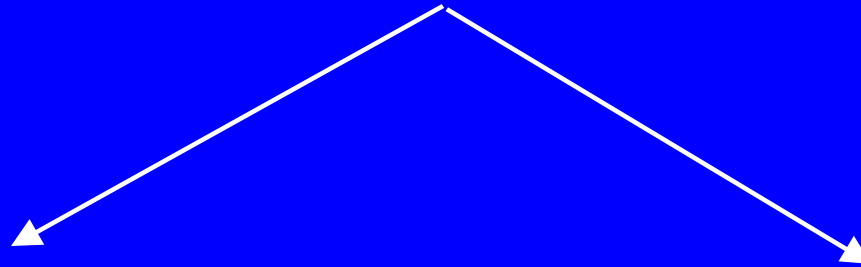
The separate and joint distributions of exposures - within a specific study population - determine the statistical power available to examine the risk associated with each one

Work Organization

The organization of the work process (who does what, how often, and how) determines both:

- physical loading patterns, and
- psychosocial stressors: job demands, decision latitude, social support, job insecurity

Work Organization



Frequency and
duration of hand
motions

Monotonous
work with low
skill utilization

“Psychosocial” or “Physical” Strain?



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“Psychosocial” or “Physical” Risk Factors

Work organization features that imply rapid motions without rest breaks:

- Work without rest breaks or task change, for at least 15% of the shift (Roquelaure 1997)
- Piece-rate vs. hourly wages (Brisson 1989)
- Just-in-time production system (Leclerc 1998)

All associated with elevated risk of MSDs

The Debate: Cross-Sectional Studies

- Only currently employed people
 - Exposed persons developing W-R MSDs may have left employment disproportionately (“healthy worker effect”)
- Concurrent health and exposure data
 - Temporal relationship: Does the health effect precede the exposure?

NRC/IOM Conclusions

2. The evidence justifies identifying certain work-related risk factors for the occurrence of MSDs of the low back and upper extremities.
6. Modification of those physical and psychosocial factors at work could substantially reduce risk of symptoms for low back and upper extremity disorders.

Attributable Fraction (AF)

Attributable fraction ($AF_e = (RR - 1)/RR$)

Risk in the exposed divided by risk in the unexposed

Interpretation:

Proportion of disease reduced if exposure eliminated

Relative importance of exposure reduction in those settings where the exposure is prevalent

(NRC/IOM, 2001)

Attributable fractions for
occupational physical risk factors
and the occurrence of back disorders

Risk Factor	Null n	Positive n	AF% (Range)
MMH	4	24	11-66
Frequent bending and twisting	2	15	19-57
Heavy physical load	0	8	31-58
Static work posture	3	3	14-32
Whole-body vibration	1	16	18-80

Attributable fractions for
occupational psychosocial risk factors
and the occurrence of back disorders

Risk Factor	Null n	Positive n	AF% (Range)
High job demands (work pace)	1	5	21-48
Monotonous work	2	4	23
Low social support at work	0	7	28-48
Low job satisfaction	1	13	17-69
High perceived stress	0	3	17

Attributable fractions for occupational psychosocial risk factors and the occurrence of back disorders (2)

Risk Factor	Null n	Positive n	AF% (Range)
Low decision latitude/control	0	2	-
High perceived emotional effort	0	3	-
Perceived ability to return to work	0	3	-
Perceived work dangerous to back	0	2	-

Attributable fractions for
occupational physical risk factors
and the occurrence of upper limb disorders

Risk Factor	Null n	Positive n	AF% (Range)
Repetition	4	4	53-71
Force	1	2	78
Repetition and force	0	2	88-93
Repetition and cold	0	1	89
Vibration	6	26	44-95

Attributable fractions for
occupational psychosocial risk factors
and the occurrence of upper limb disorders

Risk Factor	Region	Null n	Positive n	AF% (range)
High job demands	All	6	10	33-58
	Elbow/Arm	3	6	50-58
	Shoulder	6	6	33-47
	Wrist	4	5	37-56
Low decision latitude	All	10	6	37-64
	Elbow/Arm	5	1	64
	Shoulder	8	6	37-47
	Wrist	8	3	37-84

Attributable fractions for occupational psychosocial risk factors and the occurrence of upper limb disorders (2)

Risk Factor	Region	Null n	Positive n	AF% (range)
Low social support	All	7	7	28-52
	Elbow/Arm	5	0	-
	Shoulder	7	5	-
	Wrist	4	3	28-52
Few rest break opportunities	All	3	3	33-70
	Elbow/Arm	1	1	67
	Shoulder	3	1	70
	Wrist	5	2	33%

Note: Low job satisfaction not positive in studies reviewed

Physical Stressors and MSDs

- Repetitive motion
- MMH and manual forceful exertions
- Non-neutral postures (static or dynamic)
- Vibration (whole-body and segmental)
- Cold in repetitive work

Psychosocial Stressors and MSDs

High job demands

- Rapid work pace
- Few rest break opportunities

Low decision latitude

Monotonous work (low skill utilization)

Perceived job stress

- Low job satisfaction
- Job insecurity

Endorsements of Ergonomics Rulemaking to Prevent Musculoskeletal Disorders

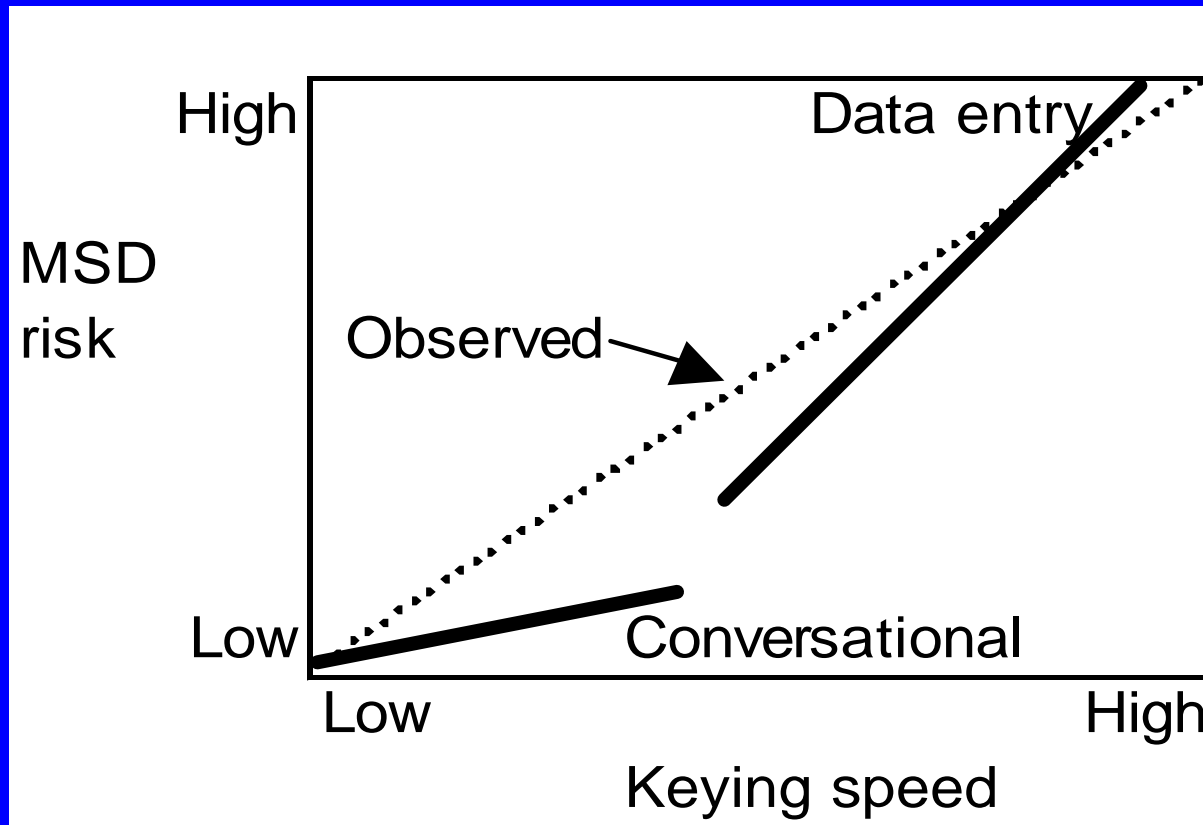
- American Conference of Governmental Industrial Hygienists (1999+)
- European Agency for Safety and Health at Work, EU (1999)
- SALTSA: Joint Programme for Working Life Research in Europe (2000)
- Washington State Dept. of Labor and Industries

Conclusions

- International near-consensus on occurrence of work-related MSDs
- A sizable proportion of MSDs among exposed workers are preventable
- Voluntary employer efforts are important but not sufficient

National Research Council
and Institute of Medicine.
*Musculoskeletal Disorders
and the Workplace: Low Back
and Upper Extremities.*
Washington DC: National
Academy Press. 2001.

Effect modification: Keying speed & type of VDT work (hypothetical)



Average hand forces associated with elevated risk of upper extremity disorders

- > 4 kg (Silverstein 1986, 1987;
Armstrong 1987)
- > 3 kg (Chiang 1993)
- > 2.7 kg per hand (Stetson 1993)
- > 4 kg carry (Stetson 1993)
- > 1 kp (Roquelaure 1988)

Effect modification: Physical load by gender

One-year incidence of UE MSDs in auto manufacturing

