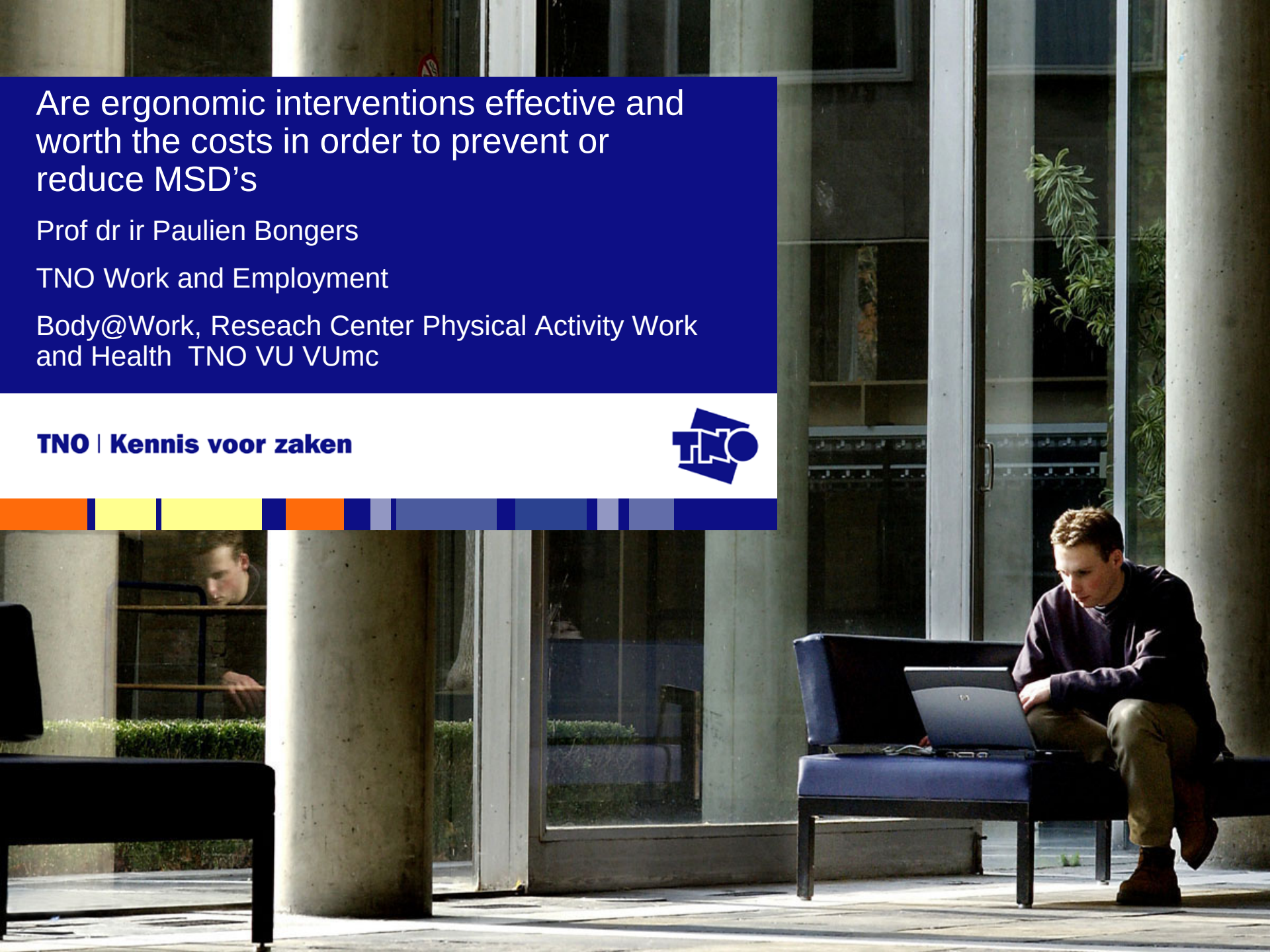
# Are ergonomic interventions effective and worth the costs in order to prevent or reduce MSD's

Prof dr ir Paulien Bongers

TNO Work and Employment

Body@Work, Reseach Center Physical Activity Work and Health  TNO VU VUmc

TNO | Kennis voor zaken



# Are ergonomic interventions effective to prevent or reduce MSD's?

27 EU countries

- 25% Low back pain
- MSD most important reason for absence from work (ca 40%)
- With as a result 1,6% Gross Domestic Product
- Reduced company profitability not well documented

(Eurofound 2008)

Aim of the presentation:

1. Summarize the collective evidence on effectiveness of prevention of MSD by applying ergonomic interventions
2. Provide the state of the art on what does and what does not seem to work

# Prevention of health complaints is not easy

1. Target the risk factor with the highest attributable fraction

2. Target the relevant risk factor
   - Most risk factors are different per body part
   - What level and aspect of exposure is relevant, i.e. total dose or peaks?

3. Target a risk factor that is changeable

4. Develop an intervention that can be implemented and does reduce the relevant risk factor to an acceptable level

5. Evaluate the intervention on effectiveness with respect to a) reduction of the risk and b) outcome

6. Apply the most cost effective intervention

# So what do we need for effective prevention of MSD?

Per prevalent MSD complaint

1. Well established risk factors (ie sufficient detail and consistent evidence)
2. Knowledge about the prevalence of these risk factors

Per risk factor or set of risk factors

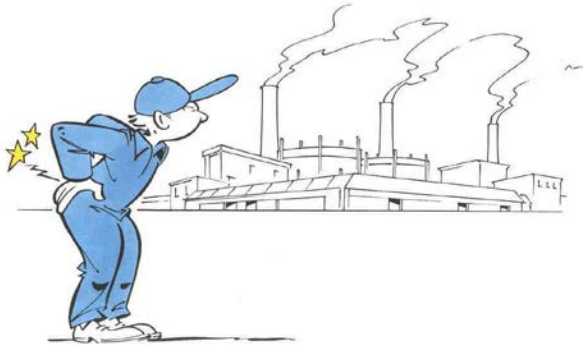
3. Which interventions are available and can be implemented for whom
4. Which interventions are effective in reduction of these risk factor and as a consequence complaints or disease

Separated for LBP and neck/ upper limb

# Risk factors for LBP

There is general consensus on the main work related risk factors for LBP:

1. Lifting/ Manual Material Handling
2. Non neutral trunk posture (mainly trunkflexion)
3. Whole body vibration



(ao Hoogendoorn et al 1999, Kuiper et al 1999, NRC 2001, Lotters et al 2003, Tiemessen et al 2008, Griffith et al 2008,
*However very recent reviews reach other conclusions Bakker et al 2009, Wai et al 2009)*

- Extensive meta analysis with individual participant data from 18 studies
- The amount of evidence varied between 2 and 14 studies from and a total number of 1,346 to 22,972 subjects
  Thesis Lauren Griffith University of Toronto/ Institute for Work and Health 2008

# Risk factors for LBP

| Summary OR | LBP 6-12 month | Current LBP | Sick leave LBP |
|---|---|---|---|
| Non neutral trunk posture | 1.27 (1.22,1.32) | 1.20 (1.17,1.24) | 1.63 (0.88, 3.03) |
| Lifting | 1.61 (1.32, 1.97) | | 2.03 (1.71, 2.40) |
| Heavy lifting | 1.43 (1.31, 1.56) | | 2.11 (1.93, 2.30) |

Pooled OR ranged from 1.14 for a 20% increase (about 1.6 hours extra) time spent in trunk flexion for LBP in the previous 6 to 24 months to 2.40 for any non-neutral trunk posture for sick leave because of back pain

# Risk factors for LBP conclusion

1. Lifting and trunk flexion both increase the risk of LBP
2. Associations with sick leave generally the highest
3. The overall risk can be high for those exposed much of their work shifts
4. The conclusions were the same for different ways of summarizing the data
5. Including a best evidence syntheses of 17 cohort and 7 case-control studies,

6. No evidence for other physical factors such as prolonged sitting or standing

7. Less consensus on the importance of work related PSF's for LBP (Hoogendoorn et al 2000, Hartvigsen et al 2004)

# Risk factors for upper limb symptoms

| | Risk |
|---|---|
| • Repetitive movements high | 2.3 – 2.5 |
| • Force exertion high | 1.8 – 9.0 |
| • High repetitive movements and force exertion (NRC, 2001) | 15.5 – 29.1 |

Conclusion:

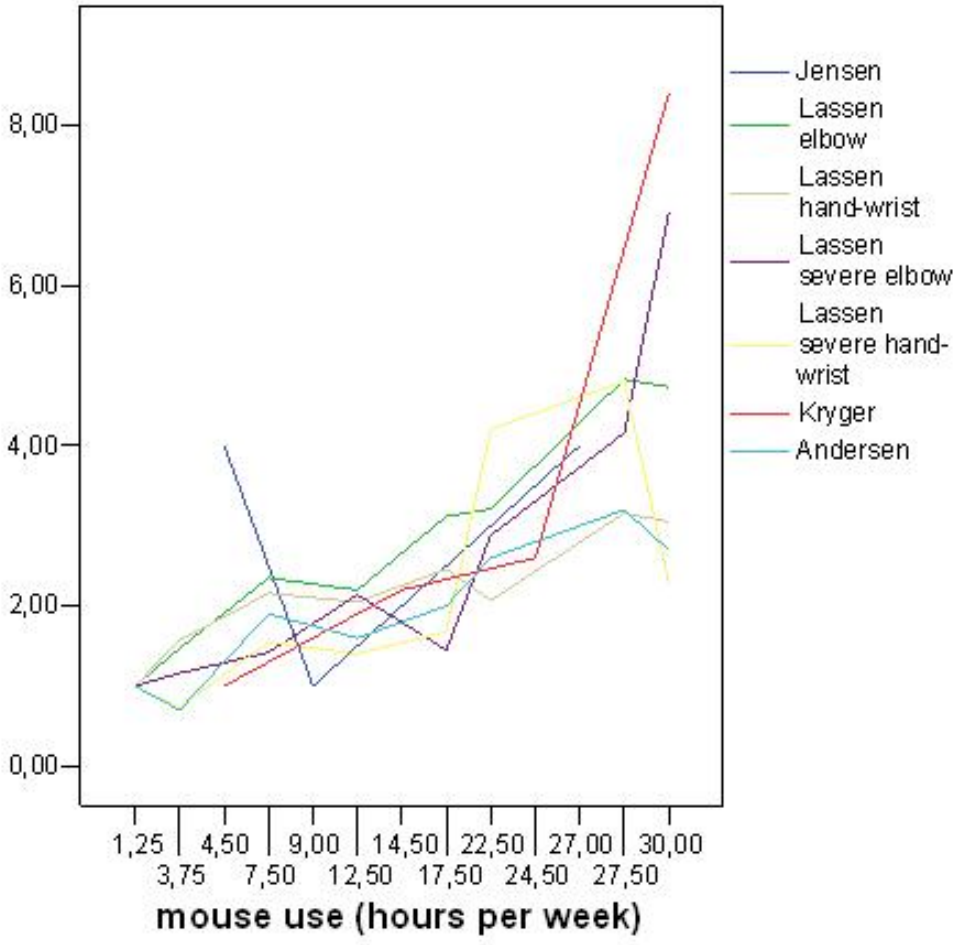
1. High force and repetitive movements in industry are important risk factors
2. The evidence needs to become more robust by combining additional studies (NIOSH consortium 2011?)

# Risk factors for upper limb symptoms

For computer workers risk factors not well established:

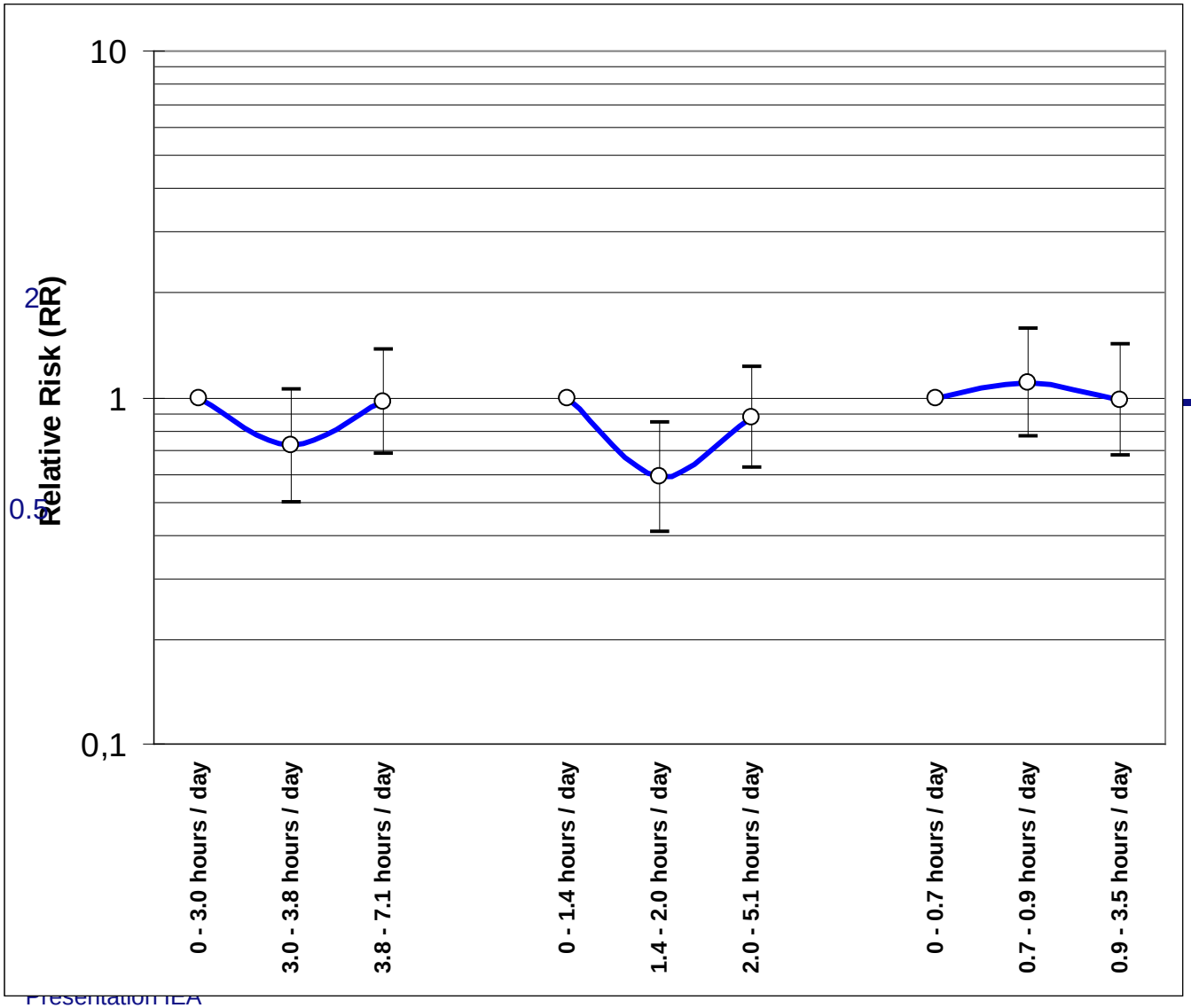
- Recent review relationship with self reported computer use IJmker et al 2007
- Several recent studies with objective data registration of computer use (Larssen et al 2005, Andersson et al 2008, Chang et al 2007, IJmker et al submitted)
- Several recent longitudinal studies investigating the relationship between upper limb problems and workplace lay out and postural variables during computer work

# Risk factors for upper limb symptoms in computer use (Review IJmker et al 2007)




Also applies to college students (Menendez et al 2009)

# Risk factors for upper limb for computer users




Increased risk compared with reference category

Decreased risk compared with reference category

total computer use mouse use keyboard use

# Risk factors for upper limb and neck shoulder problems

Other studies with registered computer data are in the same line

- Computer mouse use predicts acute pain but not prolonged/chronic pain in the neck and shoulder Andersen et al 2007
- Moderate relation computer use and arm/wrist pain Chang et al 2007
- No consistent evidence for association posture/ workstation lay out and complaints for computer users (Andersen et al 2003, 2007, Chang et al 2007, Larssen et al 2005, Menendez et al 2007, vd Heuvel et al 2006, Marcus et al 2002)

Conclusion:

- Positive evidence between self reported duration of mouse use
- Conflicting evidence and at the most only slight effects of duration of computer use, when registered, and upper limb and neck problems
- For workstation lay out only conflicting evidence

- Work related psychosocial factors no consistent relation (Bongers et al 2006)

# Conclusions Risk factors for MSD as basis for ergonomic interventions

Low back pain

- Evidence for lifting and trunk flexion being risk factors for LBP
- For the high exposed, the overall risks can be high
- No other consistent physical risk factors
- Conflicting and no consistent evidence for work related psychosocial factors

►Thus the evidence on risk factors for LBP is mainly a basis for effective ergonomic interventions in ‘heavy work jobs’ not in office work

Neck/Upper limb

- High force and repetitive movement important risk factors
- No or weak evidence for an effect of duration of computer use
- No consistent evidence for workstation lay out in office work
- Conflicting evidence work related psf (not perceived stress. general distress)

►Thus the evidence on risk factors for UL is mainly a basis for effective ergonomic interventions in ‘heavy work jobs’ not in office work

# Effectiveness of interventions to prevent MSD

1. Interventions aimed at the individual worker
   - Lumbar support or backbelts (not effective LBP, van Poppel et al 1997, Maher et al 2000, Amendolia et al 2004, van Duijvenbode et al 2008, Bigos et al 2009)
   - Physical exercise programs to improve strength/ work capacity (effective LBP, Burton et al EU guidelines for prevention of LBP 2006, Bigos et al 2009, based on 7 out of 8 positive high quality trials)
   - Advice, instruction or education about working methods or lifting techniques

2. Interventions at the workplace (ergonomics)
   - Workplace adjustments/ redesign (ie lifting aids, other equipment, machines, lay out)
   - Organisational changes (ie job rotation, job enlargements, changes in logistics etc)

# Effectiveness of interventions to prevent LBP

Preventive interventions for LBP, systematic reviews:

1. Frank et al 1996
2. Westgaard & Winkel 1997
3. Linton et al 2001
4. Jellema et al 2001
5. Van Poppel et al 2004
6. Tveito et al 2004
7. Burton et al 2006 'LBP: guidelines for its management'
8. Bos et al 2006
9. Amick et al 2006
10. Dawson et al 2007
11. Martimo et al 2007 (11 trials evidence synthesis and meta analysis)
12. Griffith et al 2008 (12 reviews evidence synthesis)
13. Bigos et al 2009 (20 trials, most but not all RCT)
14. Driessen et al 2009 (3 RCT evidence synthesis and Meta analysis)

# Effectiveness of interventions to prevent NP

- Preventive interventions neck/shoulder/ upper limb pain, systematic reviews

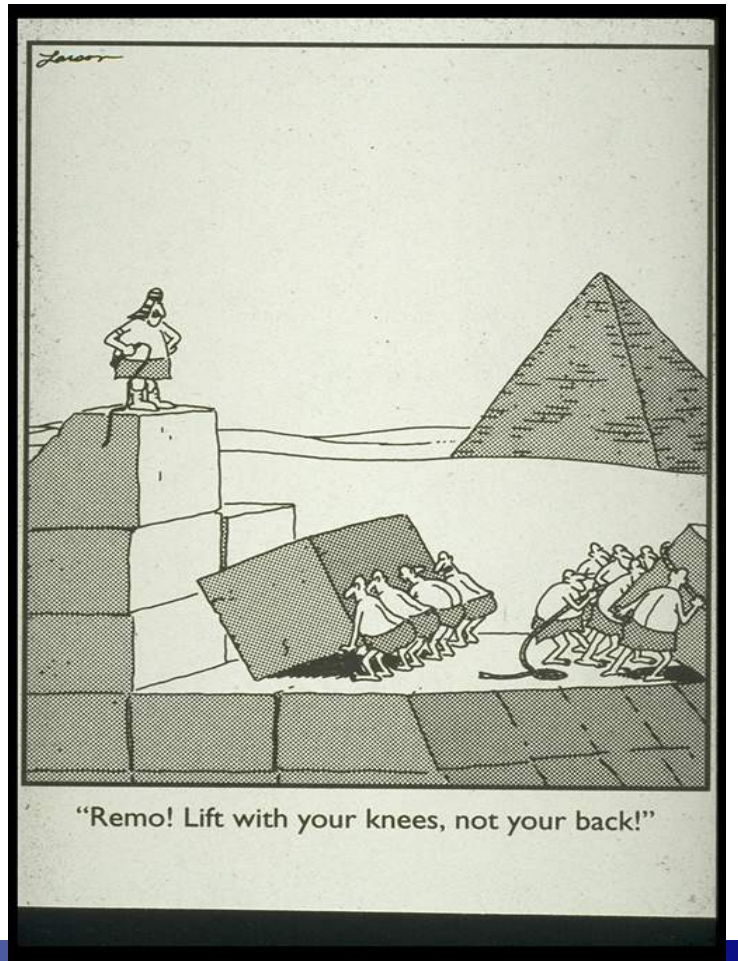
1. Brewer et al 2006 (MSD and Office work 31 studies)
2. Boocock et al 2007 (neck and upper limb 30 studies)
3. Driessen et al 2009 (neck and LBP l10 studies)

In general, in recent years the quality of evaluation studies has increased very much, thus adding to the body of evidence on effectiveness of interventions

# Effectiveness of interventions to prevent LBP

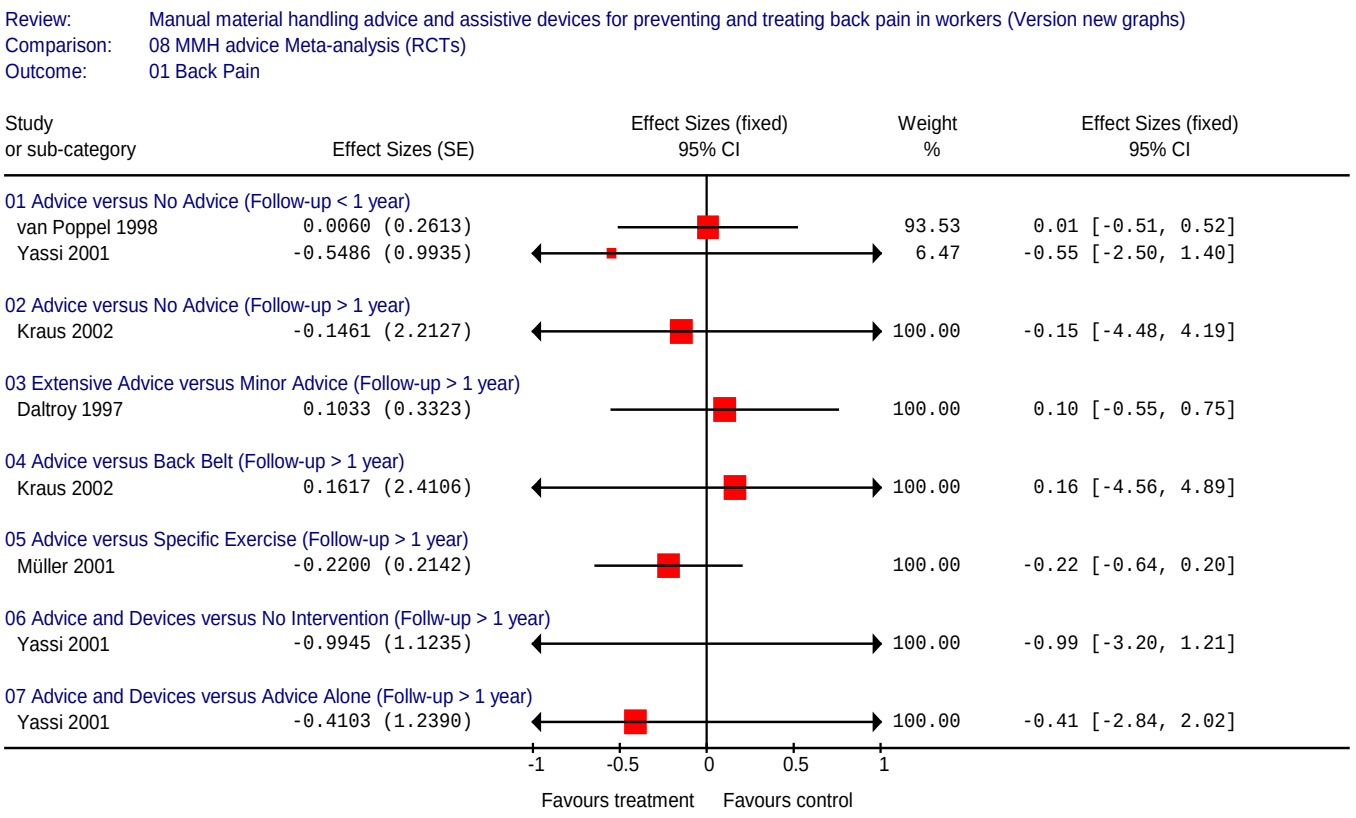
Manual Material Handling Advice, training and other programmes with and without additional lifting aids for prevention of LBP

- Evidence for heavy lifting being a risk factor
- In many occupations it is not possible to avoid heavy loads
- Advice about lifting techniques is abundant
- Important intervention for occupational health professionals



# Effectiveness of interventions to prevent LBP

## Results based on review of 6 RCTs + 5 Cohort Studies (Martimo et al 2007)



# Effectiveness of interventions to prevent LBP

For preventing  back pain or back pain related disability

- MMH advice not more effective than
  - no advice (3 RCTs)
  - very brief  advice (1 RCT)
  - physical exercise (1 RCT)
  - back belt use (2 RCTs)
- MMH advice and assistive devices not more effective than
  - MMH advice alone (1 RCT)
  - no advice (1 RCT)
- Cohort studies reported the same results

# Effectiveness of interventions to prevent LBP

Confirmed by Bigos et al 2009

- 4 Education combined with training, advice, lifting methods, working technique, workplace advice
- 4 Reduction of lifting with work place policies, training and mechanical lifting devices (all health care)

- Four additional studies not included by Martimo (Donchin et al 1990, Smedley et al 2003*, Jensen et al 2006*, IJzelenberg et al 2007)
- All negative trials

Conclusion, the existing trials do not provide evidence for an effect of ergonomic advice and programmes to reduce lifting on prevention or reduction of LBP

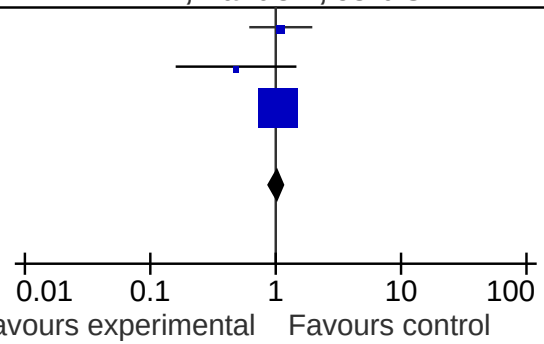
# Effectiveness of interventions to prevent LBP

## Meta-analyses of three studies on ergonomic interventions other than lifting reduction compared to no intervention (Driessen et al 2009)

| | Experimental | | Control | | | Risk Ratio | Risk Ratio |
|---|---|---|---|---|---|---|---|
| **Study or Subgroup** | **Events** | **Total** | **Events** | **Total** | **Weight** | **M-H, Random, 95% CI** | **M-H, Random, 95% CI** |
| Brisson 1995 | 22 | 283 | 24 | 339 | 9.8% | 1.10 [0.63, 1.92] | |
| Cook 2007 | 4 | 30 | 8 | 29 | 2.6% | 0.48 [0.16, 1.43] | |
| Haukka 2008 | 126 | 263 | 111 | 241 | 87.7% | 1.04 [0.86, 1.25] | |
| **Total (95% CI)** | | **576** | | **609** | **100.0%** | **1.03 [0.86, 1.22]** | |
| Total events | 152 | | 143 | | | | |

Heterogeneity: Tau² = 0.00; Chi² = 1.93, df = 2 (P = 0.38); I² = 0%

Test for overall effect: Z = 0.28 (P = 0.78)



# Conclusion on effectiveness of interventions to prevent LBP

1. Interventions aimed at the individual worker
   - Physical exercise programs: **effective**
   - Lumbar support or back belts: **not effective**
   - Advice, instruction or education about working methods or lifting techniques: **not effective**

2. Interventions at the workplace (ergonomics)
   - Workplace adjustments/ redesign: **not effective as far as lifting is concerned,** other interventions few data
   - Organisational changes: **hardly any studies**, or at least no studies that passed the selection criteria of the valid evaluations

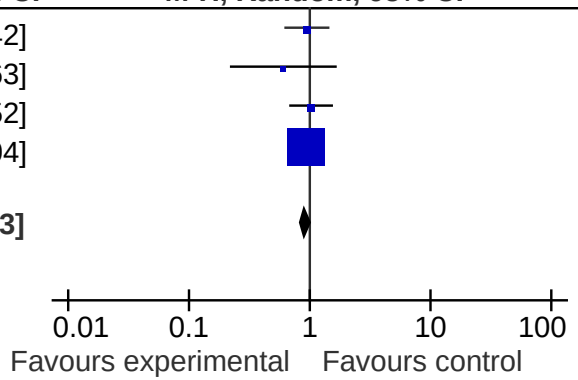
# Effectiveness of interventions to prevent NP

## Meta-analyses of four studies on ergonomic interventions short term NP compared to no intervention (Driessen et al 2009)

| Study or Subgroup | Experimental Events | Experimental Total | Control Events | Control Total | Weight | Risk Ratio M-H, Random, 95% CI |
|---|---|---|---|---|---|---|
| Brisson 1995 | 36 | 282 | 46 | 341 | 6.8% | 0.95 [0.63, 1.42] |
| Cook 2007 | 5 | 30 | 8 | 29 | 1.1% | 0.60 [0.22, 1.63] |
| Gerr 2005 | 36 | 116 | 33 | 109 | 7.3% | 1.03 [0.69, 1.52] |
| Haukka 2008 | 176 | 263 | 174 | 241 | 84.7% | 0.93 [0.83, 1.04] |
| **Total (95% CI)** | | **691** | | **720** | **100.0%** | **0.93 [0.84, 1.03]** |
| Total events | 253 | | 261 | | | |

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.97$, df = 3 (P = 0.81); $I^2 = 0\%$

Test for overall effect: Z = 1.33 (P = 0.18)



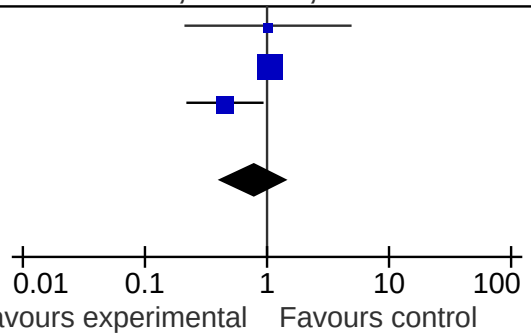
# Effectiveness of interventions to prevent NP

## Meta-analyses of four studies on ergonomic interventions  long term NP compared to no intervention (Driessen et al 2009)

| | Experimental | | Control | | | Risk Ratio | Risk Ratio |
|---|---|---|---|---|---|---|---|
| **Study or Subgroup** | **Events** | **Total** | **Events** | **Total** | **Weight** | **M-H, Random, 95% CI** | **M-H, Random, 95% CI** |
| Conlon 2008 | 3 | 51 | 3 | 52 | 13.5% | 1.02 [0.22, 4.82] | |
| Haukka 2008 | 184 | 263 | 159 | 241 | 53.2% | 1.06 [0.94, 1.20] | |
| Rempel 2006 | 8 | 40 | 19 | 43 | 33.4% | 0.45 [0.22, 0.92] | |
| **Total (95% CI)** | | **354** | | **336** | **100.0%** | **0.79 [0.41, 1.53]** | |
| Total events | 195 | | 181 | | | | |

Heterogeneity: Tau² = 0.21; Chi² = 5.76, df = 2 (P = 0.06); I² = 65%

Test for overall effect: Z = 0.69 (P = 0.49)



# Effectiveness of interventions to prevent NP/ Upper limb problems

- Driessen et al 2009
  - No evidence workplace adjustment
- Boocock et al 2007 (NP and UL):
  - Moderate evidence for alternative computer input devices mouse and keyboards
- Brewer et al 2006 (UL):
  - Moderate evidence alternative pointing devices
  - No evidence workplace adjustments, rest breaks
- Recent studies some support for forearm support and positive effects of upper limb
- All in all evidence still too scattered to draw robust conclusions, however more studies on their way and some potential in specific interventions to change wrist posture or armsupport

| | Evidence for effectiveness | No evidence for effectiveness | Insufficient evidence due to lack of studies |
|---|---|---|---|
| Evidence that it is a risk factor | | Heavy lifting or lifting during much of the working time | Trunk flexion > 30° for much of the working time<br><br>High repetition and high force environments |
| No evidence for the risk factor | Specific interventions for computer users with respect to wrist posture | General postural and work station interventions for computer users; Duration of computer use | |

| | Evidence for effectiveness | No evidence for effectiveness | Insufficient evidence due to lack of studies |
|---|---|---|---|
| Evidence that it is a risk factor | ?? | Heavy lifting or lifting during much of the working time<br><br>Effectiveness and Efficacy | Trunk flexion > 30° for much of the working time<br>High repetition and high load environments |
| No evidence for the risk factor | Specific interventions for computer users with respect to wrist posture<br>+- | ~~General postural and work station interventions for computer users; Duration of computer use~~ | |

# Discussion

The results of the results on lacking effectiveness of lifting interventions may be used as an argument against the conclusion that force on the spine due to lifting is a risk factor, but this does not have to be the case

Efficacy: i.e whether an intervention cán change the outcome
Effectiveness: whether the intervention actually does change the outcome in the real world

So with the current state of the art we can conclude the effectiveness is low but this may have more reasons besides that there is no association after all between the risk factor and outcome ie

- Non compliance
- The exposure is not effected (some indications of compliance but very little information on actual reduction of load in the studies
- Counteract effect ie do more patients

# Recommendations for research and practice

We have made so much progress, but it is not enough for robust evidence

Risk factor studies

- No more cross sectional studies
- No self reported exposure
- Building on existing studies to make pooling possible

Interventions

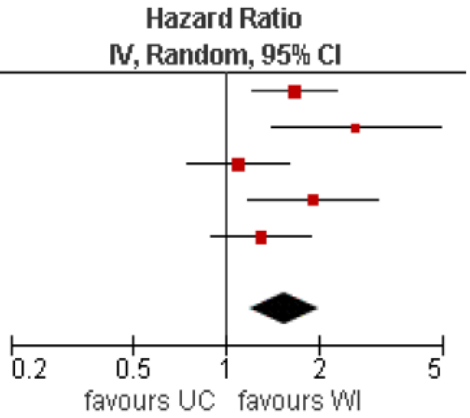
- Start interventions in high risk environments, evaluate these with low risk of bias
- No use for interventions to prevent LBP in an office environment
- No use for workstation adjustments in office environment for the prevention of MSD
- Build on existing evidence
- Evaluate reduction of exposure and other intermediates
- Report on compliance and process
- Apply interventions with a high chance of implementation (intervention mapping)
- Conduct a cost-benefit or cost effectiveness analysis
- Orient the ergonomic interventions in the low risk area's for MSD to improve comfort, performance, willingness to work at higher age etc etc

# Effectiveness of an ergonomic intervention to enhance return to work

## Effect on time to return to work of workplace intervention versus no work place intervention

| Study or Subgroup | log[Hazard Ratio] | SE | WI Total | UC Total | Weight | Hazard Ratio IV, Random, 95% CI |
|---|---|---|---|---|---|---|
| Anema/Steenstra 2007 | 0.5128 | 0.1628 | 96 | 100 | 25.9% | 1.67 [1.21, 2.30] |
| Blonk 2006 | 0.969642 | 0.321 | 35 | 34 | 12.1% | 2.64 [1.41, 4.95] |
| Feuerstein 2003 | 0.093 | 0.194 | 59 | 64 | 22.2% | 1.10 [0.75, 1.61] |
| Loisel 1997 | 0.6471 | 0.2464 | 47 | 57 | 17.1% | 1.91 [1.18, 3.10] |
| Verbeek 2002 | 0.2623 | 0.1906 | 61 | 59 | 22.6% | 1.30 [0.89, 1.89] |
| **Total (95% CI)** | | | **298** | **314** | **100.0%** | **1.55 [1.20, 2.01]** |

Heterogeneity: Tau² = 0.04; Chi² = 7.63, df = 4 (P = 0.11); I² = 48%
Test for overall effect: Z = 3.35 (P = 0.0008)




Van Oostrom et al 2009
Tompa et al 2008, Credible evidence supporting the financial benefits of ergonomic interventions to enhance return to work after sick leave due to LBP