Ergonomics – risk assessment of hand intensive repetitive work

Mikael Forsman
Professor, Division of Ergonomics, KTH Royal Institute of Technology
Introduction

Work-related musculoskeletal disorders and sick-leave are still frequent.

Musculoskeletal disorders constitute 40% of global compensation costs of occupational and work-related injuries and diseases.

Work-related musculoskeletal disorders are the most frequent occupational diseases in the European Union.

Work postures, work movements, physical loads, repetitive tasks and psychosocial conditions are risk factors.
Hand intensive work

New provisions from the Swedish Work Environment Authority, states that all employees with hand intensive tasks should be offered medical controls.

- Rapid sustained wrist movements against the outer positions of the joint in combination with force
- However, this does not apply if an in-depth assessment shows that the work does not provide an increased risk of strain problems in the neck, shoulder, arm or hand.
Interventions

The basic intervention phases are:

• problem identification – risk assessment
• idea and solution development
• implementation
What may happen if non-reliable methods are used for risk assessments?

- Risks may be unidentified
- Non-risks may be seen as risks
- Risks of different work moments may be erroneously ranked
- Intervention evaluations may be wrong
Technical methods
Observational methods

HAL, RULA, QEC, STRAIN INDEX, KIM, …
Observation Method Example - Quick Exposure Check (QEC)

**Observer’s Assessment**

**Back**

A When performing the task, is the back (select worse case situation)
- A1 Almost neutral?
- A2 Moderately flexed or twisted or side bent?
- A3 Excessively flexed or twisted or side bent?

B Select **ONLY ONE** of the two following task options:

**EITHER**

- For seated or standing stationary tasks. Does the back remain in a **static** position most of the time?
  - B1 No
  - B2 Yes

**OR**

- For lifting, pushing/pulling and carrying tasks (i.e. moving a load). Is the movement of the back
  - B3 Infrequent (around 3 times per minute or less)?
  - B4 Frequent (around 8 times per minute)?
  - B5 Very frequent (around 12 times per minute or more)?

**Shoulder/Arm**

C When the task is performed, are the hands (select worse case situation)
- C1 At or below waist height?
- C2 At about chest height?
- C3 At or above shoulder height?

D Is the shoulder/arm movement
- D1 Infrequent (some intermittent movement)?
- D2 Frequent (regular movement with some pauses)?
- D3 Very frequent (almost continuous movement)?

**Worker’s Assessment**

**Workers**

H Is the maximum weight handled **MANUALLY BY YOU** in this task?
- H1 Light (5 kg or less)
- H2 Moderate (6 to 10 kg)
- H3 Heavy (11 to 20 kg)
- H4 Very heavy (more than 20 kg)

J On average, how much time do you spend per day on this task?
- J1 Less than 2 hours
- J2 2 to 4 hours
- J3 More than 4 hours

K When performing this task, is the maximum force level exerted by one hand?
- K1 Low (e.g. less than 1 kg)
- K2 Medium (e.g. 1 to 4 kg)
- K3 High (e.g. more than 4 kg)

L Is the visual demand of this task
- L1 Low (almost no need to view fine details)?
- L2 High (need to view some fine details)?
  *If High, please give details in the box below

M At work do you drive a vehicle for
- M1 Less than one hour per day or Never?
- M2 Between 1 and 4 hours per day?
- M3 More than 4 hours per day?
Observation Method Example - Quick Exposure Check (QEC)

Observer’s Assessment

Wrist/Hand

E Is the task performed with
(select worse case situation)
E1 An almost straight wrist?
E2 A deviated or bent wrist?

F Are similar motion patterns repeated
F1 10 times per minute or less?
F2 11 to 20 times per minute?
F3 More than 20 times per minute?

Neck

G When performing the task, is the head/neck
bent or twisted?
G1 No
G2 Yes, occasionally
G3 Yes, continuously

Worker’s Assessment

N At work do you use vibrating tools for
N1 Less than one hour per day or Never?
N2 Between 1 and 4 hours per day?
N3 More than 4 hours per day?

P Do you have difficulty keeping up with this work?
P1 Never
P2 Sometimes
*P3 Often
* If Often, please give details in the box below

Q In general, how do you find this job
Q1 Not at all stressful?
Q2 Mildly stressful?
*Q3 Moderately stressful?
*Q4 Very stressful?
* If Moderately or Very, please give details in the box below
Observation Method Example - Quick Exposure Check (QEC)

Back
- Back Posture (A) & Weight (H)
  - A1, A2, A3
  - H1: 2 4 6
  - H2: 4 6 8
  - H3: 6 8 10
  - H4: 8 10 12
  - Score 1
- Back Posture (A) & Duration (J)
  - J1, J2, J3
  - J1: 2 4 6
  - J2: 4 6 8
  - J3: 6 8 10
  - Score 2
- Duration (J) & Weight (H)
  - J1, J2, J3
  - J1: 2 4 6
  - J2: 4 6 8
  - J3: 6 8 10
  - Score 3

Shoulder/Arm
- Height (C) & Weight (H)
  - C1, C2, C3
  - H1: 2 4 6
  - H2: 4 6 8
  - H3: 6 8 10
  - H4: 8 10 12
  - Score 1
- Height (C) & Duration (J)
  - J1, J2, J3
  - J1: 2 4 6
  - J2: 4 6 8
  - J3: 6 8 10
  - Score 2
- Duration (J) & Weight (H)
  - J1, J2, J3
  - J1: 2 4 6
  - J2: 4 6 8
  - J3: 6 8 10
  - Score 3

Wrist/Hand
- Repeated Motion (F) & Force (K)
  - F1, F2, F3
  - K1: 2 4 6
  - K2: 4 6 8
  - K3: 6 8 10
  - Score 1
- Repeated Motion (F) & Duration (J)
  - J1, J2, J3
  - J1: 2 4 6
  - J2: 4 6 8
  - J3: 6 8 10
  - Score 2
- Duration (J) & Force (K)
  - J1, J2, J3
  - J1: 2 4 6
  - J2: 4 6 8
  - J3: 6 8 10
  - Score 3

Neck
- Neck Posture (G) & Duration (J)
  - G1, G2, G3
  - J1: 2 4 6
  - J2: 4 6 8
  - J3: 6 8 10
  - Score 1
- Visual Demand (L) & Duration (J)
  - L1, L2
  - J1: 2 4
  - J2: 4 6
  - J3: 6 8
  - Score 2

Total score for Neck
Sum of Scores 1 to 2

Driving
- M1, M2, M3
  - M1: 1 4 9
# Task Analysis

**Back**
- Back Posture (A) & Weight (B)
  - H1: 2 4 6
  - H2: 4 6 8
  - H3: 8 10 12

**Shoulder/Arm**
- Back Posture (A) & Duration (B)
  - J1: 2 4 6
  - J2: 4 6 8
  - J3: 8 10 12

**Wrist/Hand**
- Weight (A) & Duration (B)
  - K1: 2 4 6
  - K2: 4 6 8

**Nock**
- Nock Posture (A) & Duration (B)
  - J1: 2 4 6

### Total scores
- Total score for Back
  - Sum of Scores 1 to 3 plus 1 for H1
- Total score for Shoulder/Arm
  - Sum of Scores 1 to 5
- Total score for Wrist/Hand
  - Sum of Scores 1 to 5
- Total score for Nock
  - Sum of Scores 1 to 2

### Additional Metrics
- Driving
  - Total for Driving
  - M1 2 4 6
- Vibration
  - Total for Vibration
  - N1 2 4 6
- Work pace
  - Total for Work pace
  - P1 2 4 6
- Stress
  - Total for Stress
  - Q1 2 4 6
Observational methods

The RAMP package for MSD risk management in manual handling – A freely accessible tool, with website and training courses

Linda M. Rose a,*, Jörgen Eklund a, d, Lena Nord Nilsson a, b, Linda Barman c, Carl M. Lind a, d

a KTH Royal Institute of Technology, School of Engineering Sciences in Chemistry, Biotechnology and Health, Department of Biomedical Engineering and Health Systems, Division of Ergonomics, Hälsovägen 11C, SE-141 57, Huddinge, Sweden
b Scania CV AB, Department of Safety and Health, Södertälje, Sweden
c KTH Royal Institute of Technology, School of Industrial Engineering and Management, Department of Learning in Engineering Sciences, Sweden
d Karolinska Institutet, Institute of Environmental Medicine, Unit of Occupational Medicine, Stockholm, Sweden
The RAMP package for MSD risk management in manual handling – A freely accessible tool, with website and training courses

Linda M. Rose a, *, Jörgen Eklund a, d, Lena Nord Nilsson a, b, Linda Barman c, Carl M. Lind a, d

Abstract

In this paper the RAMP Package is presented with the objective to facilitate the application of the RAMP tool to systematically manage MSD risks. The package consists of the RAMP tool (Risk Assessment and Management tool for manual handling Proactively), the RAMP website, and free, globally available online, training courses (MOOCs). An Action module used for managing identified MSD risks is introduced. The tool, encompassing a wide range of risks, is applicable to the whole risk management process. Furthermore, RAMP is openly available for download, and free to use. The RAMP tool and training materials were developed using a participative iterative methodology including researchers and practitioners. RAMP was downloaded in 86 countries in the first 26 months since its’ launch and over 2400 learners from high-, middle- and low-income countries have joined the MOOCs. The RAMP Package meets organisations’ needs for an accessible, comprehensive risk assessment and management tool.
Observational methods

The RAMP tool

Fig. 1. Illustration of the RAMP tool structure with its four modules: RAMP I, RAMP II, the Results module and, the Action module.
Observation methods

Takala and co-workers, 2010, evaluated 30 observational methods, and found a need for further reliability testings.
Observation Reliability Project

12 experienced ergonomists were given:
10 video-recorded (2-5 minutes) work tasks
• supermarket work
• meat cutting and packing
• engine assembly
• cleaning
• post sorting
• hairdressing.

Data of:
the work task length, pause- and rests-schedules, weights of handled goods, and the employees’ ratings of discomfort, work demands and control, were given for each task.
The assessments were repeated after about 2 months.
The ergonomists were trained in, and used, 6 observation methods.

0. They also did an own experience – no method
1. Occupational Repetitive Actions checklist (OCRA)
2. Quick Exposure Checklist (QEC)
3. Strain Index (SI)
4. Assessment of Repetitive Tasks (ART)
5. Hand Arm Risk-assessment Method (HARM)
6. Repetitive work model by the Swedish Work Environment Authority
What is the risk for right shoulder disorder in this job?

- Low?
- Moderate?
- High?
Number of ergonomist per category

- Låg risk: 7
- Mellanrisk: 8
- Hög risk: 6
<table>
<thead>
<tr>
<th>Activity</th>
<th>Neck</th>
<th>Left shoulder</th>
<th>Left elbow</th>
<th>Left wrist</th>
<th>Right shoulder</th>
<th>Right elbow</th>
<th>Right wrist</th>
<th>Low back</th>
<th>Total risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unpack groceries to shelves</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>Moderate risk</td>
<td>Low risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Put nets around roasts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>Moderate risk</td>
<td>Low risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Throw small boxes in containers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>Moderate risk</td>
<td>Low risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Put packs of letters into boxes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>Moderate risk</td>
<td>Low risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debone meat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>Moderate risk</td>
<td>Low risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine assembly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>Moderate risk</td>
<td>Low risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hair cutting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>Moderate risk</td>
<td>Low risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilet cleaning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>Moderate risk</td>
<td>Low risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supermarket cashier work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk</td>
<td>Moderate risk</td>
<td>Low risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning stairs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

20 Ratings
OCRA over-all risk level

Proportional agreement between ergonomists (39%)
Linearly weighted kappa = 0.41

### Results

#### Reliability

<table>
<thead>
<tr>
<th>Method</th>
<th>Risk level for</th>
<th>Inter-rater</th>
</tr>
</thead>
<tbody>
<tr>
<td>QEC</td>
<td>Total (with 4 levels)</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>Total (with 3 levels)</td>
<td>0.41</td>
</tr>
<tr>
<td>HARM</td>
<td>Total</td>
<td>0.65</td>
</tr>
<tr>
<td>SI</td>
<td>Left Hand</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>Right Hand</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>The Highest Risk Hand</td>
<td>0.47</td>
</tr>
<tr>
<td>OCRA</td>
<td>Total</td>
<td>0.37</td>
</tr>
<tr>
<td>SWEA</td>
<td>Tot Risk Posture and Movements</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Sitting / Standing</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Neck</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>Back</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>Arm/Shoulder</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Leg</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Own assessment</strong></td>
<td><strong>Neck</strong></td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>Right Shoulder</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>Left Shoulder</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>Left Arm/elbow</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Right Arm/elbow</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Right Hand/wrist</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>Left Hand/wrist</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>Lower Back</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>Total Risk</td>
<td>0.31</td>
</tr>
</tbody>
</table>

**Landis & Koch (1977):**

- < 0.20  – poor
- 0.21 – 0.40  – fair
- 0.41 – 0.60  – moderate
- 0.61 – 0.80  – substantial
- 0.81 – 1.00  – almost perfect
**HARM Reliability**

**Postures**

**Neck-shoulder**

**Time in demanding postures:**

<table>
<thead>
<tr>
<th>green</th>
<th>yellow</th>
<th>red</th>
<th>0–10</th>
<th>10–50</th>
<th>&gt;50%</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image of posture" /></td>
<td><img src="image2.png" alt="Image of posture" /></td>
<td><img src="image3.png" alt="Image of posture" /></td>
<td><img src="image4.png" alt="Image of posture" /></td>
<td><img src="image5.png" alt="Image of posture" /></td>
<td><img src="image6.png" alt="Image of posture" /></td>
</tr>
</tbody>
</table>
# Inter-rater Reliability

## Repetition, Movements and Postures

<table>
<thead>
<tr>
<th>Method</th>
<th>$\kappa_w$</th>
<th>low</th>
<th>high</th>
</tr>
</thead>
<tbody>
<tr>
<td>QEC</td>
<td>0.17 - 0.44</td>
<td>Hand/wrist posture</td>
<td>Hand/wrist repetition</td>
</tr>
<tr>
<td>HARM</td>
<td>0.14 - 0.3</td>
<td>Hand/arm posture</td>
<td>Force duration/repetition</td>
</tr>
<tr>
<td>SI</td>
<td>0.04 - 0.40</td>
<td>Hand posture</td>
<td>Force repetition</td>
</tr>
<tr>
<td>OCRA</td>
<td>0.03 - 0.53</td>
<td>Elbow posture</td>
<td>Repetition</td>
</tr>
<tr>
<td>SWEA</td>
<td>0.05 - 0.22</td>
<td>Leg posture/movements</td>
<td>Neck posture/movements</td>
</tr>
<tr>
<td>Own assessment</td>
<td>0.12 - 0.27</td>
<td>Left elbow</td>
<td>Neck</td>
</tr>
</tbody>
</table>

**Landis & Koch (1977):**

- $< 0.20$ – poor
- $0.21 – 0.40$ – fair
- $0.41 – 0.60$ – moderate
- $0.61 – 0.80$ – substantial
- $0.81 – 1.00$ – almost perfect
HARM Reliability Postures

Arm-wrist

Time in demanding postures:

green yellow red

0–10 10–50 >50%

Inter-rater

$\kappa_w = 0.14$

Intra-rater

$\kappa_w = 0.25$

Landis & Koch (1977):

- $< 0.20$ – poor
- $0.21 – 0.40$ – fair
- $0.41 – 0.60$ – moderate
- $0.61 – 0.80$ – substantial
- $0.81 – 1.00$ – almost perfect
Technical methods
Validity of a small low-cost triaxial accelerometer with integrated logger for uncomplicated measurements of postures and movements of head, upper back and upper arms

Camilla Dahlqvist a, b, *, Gert-Åke Hansson a, b, Mikael Forsman c

* Occupational and Environmental Medicine, University and Regional Laboratories Region Scania, Lund, Sweden
b Division of Occupational and Environmental Medicine, Lund University, Lund, Sweden
c Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden
Validation

Camilla Dahlqvist
Lund
Tejpa på inklinometrarna med dubbelsidig toupé-tejp och eventuellt gärna med extratejp över inklinometern på respektive kroppsdel (enligt figurer), med etiketten synlig.

Huvud: På pannan, horisontell med kontakten mot högra örat. Ett ”huvudband” kan användas (Björn Borg) för att dölja och hålla mätaren på plats.

Rygg: Mellan skulderbladen, nära ryggraden med kontakten uppfåt.


Mätning och inledande referenspositioner

Huvud, rygg:
Be personen att stå och titta rakt fram i önehöjd. Starta inklinometrarna, först huvud, sen rygg, med en magnet genom att mycket kort hålla (”doppa”) magneten nära inklinometerns kontakt (startad inklinometer blinkar till och fortsätter sedan blinka snabbt gult och mer glest rött). Håll referens-positionen i 5 sekunder efter att sista (rygg-) inklinometern startats, och avsluta med en framåtbugning.
There is also a simple Excel application.
Ny mätmetod ska minska skador

TEMA ARBETSMILJÖ. Att städa är ofta belastande för kroppen och många städare får försslitningsskador. Men det är svårt att bedöma riskerna eftersom det finns lite forskning som visar hur påfrestande jobbet är. Professor Mikael Forsman vill ändra på det med en ny mätmetod.

Mätningar av belastande arm-, rygg- och nackvinklar har gjorts på liknande sätt sedan 1980-talet, men aldrig tidigare har det varit så enkelt.
– Vi har tagit fram den här metoden framför allt till fototagshålsavtalet, fram till nu har det bara varit forskare som haft tid, möjlighet och känsla även råd att mäta vinklar och belastning, säger Mikael Forsman, ergonom och professor på Centrum för arbets- och miljömedicin på Karolinska Institutet. Han har tilldelats över 2,2 miljoner kronor från Afa forskning för att testa en ny mätstrategi av belastningsnivån för olika yrkesgrupper. Det här fallet

NYHETSBREV


E-postadress
Prenumerera

SKRIV EN INSÄNDRARE

Är arbetsmiljön dålig på din arbetsplats? Får du inte rätt lön? Är du utsatt för mobbing? Vill du fråga förbundsledningen om något?

SKRIV TILL OSS

WEBBFRÅGAN

Brukar du få en julklapp från arbetsgivaren?
- Ja, vi får en julklapp varje år
- Ja, vi får julklappar och blir också bjuda på julbord eller julfika
- Nej, vi får aldrig julklappar och blir inte bjuda på julbord eller fika
- Nej, vi får aldrig julklappar och blir inte bjuda på julbord

fackliga nyheter.nu

Annonsera och nå din målgrupp i Fastighetsfolket!
Så mäter du armbelastning med mobilen

Idag räknar vi promenadsteg och klockar löprundan med hjälp av våra smarta telefoner. Doktoranden Liyun Yang har utvecklat en app som gör att man kan mäta belastning och arbetsvinkel på sin arm med telefonen.

Verktyg
- ErgoArmMeter

Forskning
ErgoArmMeter

Unit of Occupational medicine

ErgoArmMeter – A novel IOS application for measuring arm inclination

ErgoArmMeter is a professional inclinometer application for measuring arm elevation during work. It is developed by Liyun Yang (KTH Royal Institute of Technology) under the supervision of Mikael Forsman (Karolinska Institutet). This project is a collaboration between Institute of Environmental Medicine at Karolinska Institutet (KI) and School of Technology and Health at KTH Royal Institute of Technology (KTH).

It is shown by research that work with elevated arm may lead to shoulder/neck disorders. Ergonomists have been using inclinometers to measure arm elevation, which
The validation experiment in the optical motion lab. A: Placement of two reflective markers and the iPhone with armband on right arm. B: Arm flexion posture. C: Painting on a straight board.

Upper arm inclination measurement during arm flexion. From the static experiment (B in the previous figure).

The validation experiments showed a high level of agreement between the two systems. In the static experiment (B, in the experiment-figure), the mean absolute difference between the optical system's angles and those of the app was 1.5°.
<table>
<thead>
<tr>
<th>Trial</th>
<th>Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gert_</td>
<td>2016-06-20 18:31</td>
</tr>
<tr>
<td>Panos_1</td>
<td>2017-03-21 09:28</td>
</tr>
<tr>
<td>Ida_1</td>
<td>2017-03-23 10:40</td>
</tr>
</tbody>
</table>
Angle: 12°

Calibrate

Time period:

00 : 00 : 00

Start

Stop
Angle: 1°

Calibration is done.

Calibrate

Time period:

00:00:00

Start

Stop
Liyun Yang, doktorand i ergonomi, har utvecklat en app som mäter belastning och armvinklar.

FOTO: ADAM FREDHOLM
Exposure–response relationships for work-related neck and shoulder musculoskeletal disorders – Analyses of pooled uniform data sets

Catarina Nordander*, Gert-Åke Hansson, Kerstina Ohlsson, Inger Arvidsson, Istvan Balogh, Ulf Strömberg, Ralf Rittner, Staffan Skerfving

Division of Occupational and Environmental Medicine, Department of Laboratory Medicine, Lund University, SE-221 85 Lund, Sweden


Exposure–response relationships in work-related musculoskeletal disorders in elbows and hands – A synthesis of group-level data on exposure and response obtained using uniform methods of data collection

Catarina Nordander*, Kerstina Ohlsson, Ingrid Åkesson, Inger Arvidsson, Istvan Balogh, Gert-Åke Hansson, Ulf Strömberg, Ralf Rittner, Staffan Skerfving
Exposure–response relationships for work-related neck and shoulder musculoskeletal disorders — Analyses of pooled uniform data sets

Catarina Nordander*, Gert-Åke Hansson, Kerstina Ohlsson, Inger Arvidsson, Istvan Balogh, Ulf Strömberg, Ralf Rittner, Staffan Skerfving

![Graph 1 and Graph 2]

**Fig. 1.** Association between the prevalence of right-side infraspinatus tendinitis and right upper arm velocity (50th percentile) in 10 groups of female workers (N = 1044; filled circles) and 8 groups of male workers (N = 753; open diamonds). The size of the symbol corresponds to the number of workers in each of the occupational groups. Regression lines (solid for females, dotted for males) are shown together with 95% confidence intervals (by bootstrapping). The fits to the data gave the equations $y = 2.14 + 0.06x$ for women and $y = 0.45 + 0.04x$ for men, i.e. slopes of 0.06 and 0.04, respectively.

**Fig. 3.** Association between the prevalence of right-side bicipital tendinitis and angular velocity of the right wrist (50th percentile (p50)) in 15 groups of female workers (N = 1480; filled circles) and 8 groups of male workers (N = 753; open diamonds). The size of the symbol corresponds to the number of workers in each occupational group. The fits to the data gave the equations $y = 1.2 + 0.2x$ for women and $y = 0.3 + 0.1x$ for men, i.e. slopes of 0.2 and 0.1, respectively.
Work-related neck and upper limb disorders – quantitative exposure–response relationships adjusted for personal characteristics and psychosocial conditions

Istvan Balogh, Inger Arvidsson, Jonas Björk, Gert-Åke Hansson, Kerstina Ohlsson, Staffan Skerfving and Catarina Nordander

**Results:** Associations were found between head velocity, trapezius activity, upper arm velocity, forearm extensor activity and wrist posture and velocity, and most neck/shoulder and elbow/hand complaints and diagnoses. Adjustment for age, other individual characteristics and psychosocial work conditions had only a limited effect on these associations. For example, the attributable fraction for tension neck syndrome among female workers with the highest quintile of trapezius activity was 58%, for carpal tunnel syndrome versus wrist velocity it was 92% in men in the highest exposure quintile.

**Conclusions:** Based on the findings, we propose threshold limit values for upper arm and wrist velocity.
## Action levels for prevention of work related musculoskeletal disorders

<table>
<thead>
<tr>
<th></th>
<th>Action level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Median load</strong></td>
<td></td>
</tr>
<tr>
<td>Movement velocity</td>
<td></td>
</tr>
<tr>
<td>Upper arm</td>
<td>60 °/s</td>
</tr>
<tr>
<td>Wrist</td>
<td>20 °/s</td>
</tr>
<tr>
<td><strong>Posture</strong></td>
<td></td>
</tr>
<tr>
<td>Head flexion (forward)</td>
<td>25°</td>
</tr>
<tr>
<td>Elevated arm</td>
<td>30°</td>
</tr>
<tr>
<td><strong>Muscle activity</strong></td>
<td></td>
</tr>
<tr>
<td>Forearm extensor muscles</td>
<td>10 % of max</td>
</tr>
<tr>
<td><strong>Peak load</strong></td>
<td></td>
</tr>
<tr>
<td>Postures</td>
<td></td>
</tr>
<tr>
<td>Head extension (backward)</td>
<td>10°</td>
</tr>
<tr>
<td>Head flexion</td>
<td>50°</td>
</tr>
<tr>
<td>Elevated arm</td>
<td>60°</td>
</tr>
<tr>
<td><strong>Muscle activity</strong></td>
<td></td>
</tr>
<tr>
<td>Forearm extensor muscle</td>
<td>30 % of max</td>
</tr>
<tr>
<td><strong>Time for recovery</strong></td>
<td></td>
</tr>
<tr>
<td>Shoulder muscle (m Trapezius)</td>
<td>5 % of time</td>
</tr>
<tr>
<td>Forearm extensor muscles</td>
<td>5 % of time</td>
</tr>
</tbody>
</table>

*High risk of disorders at higher exposure
*If the work also is force-demanding, the action level is 15 °/second
*Elevation in relation to the vertical line
*Applies if the arms are not supported (e.g. at a table surface)
*High risk of disorders at lower time for recovery.
Gert_
2016-06-20 18:31

Panos_1
2017-03-21 09:28

Ida_1
2017-03-23 10:40

Vamilla_1
2017-04-06 15:19
Date & Time: 2017/04/06 15:19

Project: Vamilla  Recording: 1

Arm: Right arm

Trial Duration: 00h 02m 22s

<table>
<thead>
<tr>
<th>Elevation angle percentile (%tile):</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50th: 65.6°</td>
<td>30°</td>
</tr>
<tr>
<td>90th: 111.3°</td>
<td>60°</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elevation angle time percent:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 30°: 77.9%</td>
<td>50%</td>
</tr>
<tr>
<td>&gt; 60°: 53.7%</td>
<td>10%</td>
</tr>
<tr>
<td>&gt; 90°: 28.3%</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Generalized angular velocity %tile:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50th: 39.6°/s</td>
<td>60 °/s</td>
</tr>
<tr>
<td>90th: 162.4°/s</td>
<td>-</td>
</tr>
</tbody>
</table>

The red values in brackets are recommended limits for an 8-h work day, which are based on a report from Hansson et al., 2016 (in Swedish). The recommendations apply for unsupported arms.
The smart top that tracks your body posture
Hand intensive work
Hand intensive work

Experiment in uMove lab

12 subjects

Jenny Wingqvist
Josephine Lantz
Thesis Work
uMove - lab

Hairblowing
Flexion-extension. Blue = Optical Red = IMUs

40 BPM Deviation

After correlation. Vel tot markers corr (blue) and vel tot sensors filter corr (red)

Angular velocity [degrees/s]

Time [s]

After correlation. Vel tot markers corr (blue) and vel tot sensors filter corr (red)

Angular velocity [degrees/s]

Time [s]

After correlation. Vel tot markers corr (blue) and vel tot sensors filter corr (red)

Angular velocity [degrees/s]

Time [s]

90 BPM

140 BPM
Felipe Chinarro
Thesis work
Total velocity from the two Movesense sensors (deg/s)
March 18th, 2020

Four New Projects Join Movesense Academic Program

POSTED IN Academic Program, Movesense based projects
ASSESSING ARM ELEVATION AT WORK WITH TECHNICAL SYSTEMS

PEROSH Joint Research Project
Recommendations for procedures to measure occupational physical activity and workload
Conclusion

- Use systematic methods.
- There are several observational methods for repetitive work.
- With practical inexpensive inclinometers and applications in for IPhones you can obtain e.g. arm inclination – of research quality.
- We need more research on criteria for acceptable ranges (of different parameters).
- It is difficult to attract work health practitioners to start measure as a compliment to observations, the methods need to be uncomplicated, time efficient, and show useful results.

Thank you!