Upper Limb Musculoskeletal Disorders: Identification & Control of Physical Stress

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Work Factors Associated with Upper Limb Cumulative Trauma Disorders

1. Repeated or sustained exertions
2. Forceful exertions
3. Localized mechanical stresses
4. Posture stresses
5. Low temperatures
6. Vibration

Exposure-Response

Response
(Pain, Fatigue, Myalgia, Tendinitis, etc.)

Exposure (Repetition, Force, Contact, Posture)

Forceful Exertions

Exertion of force to overcome weight, resistance, or inertia of the body or a work object.

Identification & Evaluation of Force

1. Perform work methods analysis, i.e., describe job as a sequence of steps or elements
2. Inspect for forceful elements, i.e., lifting, holding, sliding, inserting or resisting
3. Observe worker
   a. Tight or bulging muscles
   b. Observed effort, e.g., leaning, jerking
   c. Reduced control

Case Packing

Objective: Pack boxes of bottles into a cardboard case
Production: 107 cases per hour
Materials: cartons, boxes of bottles
Methods:
- 1 to get flat carton (mainly LH, but RH assists)
- 2 to spread flaps (LH & RH in opposition)
- 1 to position carton
- 3 LH & 3 RH to get boxes (alters RH & LH)
- 2 to close flaps (LH & RH in opposition)
- 1 to push carton into tapping machine (LH dominates)
Worker Force Assessments of Tools Used in Automobile Assembly

**Key**

- 1 = Too Light
- 2 = Just Right
- 3 = Too Heavy

**Forceful Exertions**

- Peak force: highest force occurring during each cycle or task
- Average force: time weighted force over entire cycle or task

Force Factors

- Weight, resistance, reaction force
- Handle materials
- Gloves, friction, fit, stiffness
- Mechanical aids, e.g., supports, hoists, conveyors, power tools
- Torque control
- Handle size & shape
- Work pace
- Quality control
- Maintenance

Minimum Required Pinch Force

\[ F_p > \frac{\text{Weight}}{2 \times \text{Coefficient of Friction}} \]

- Moist skin: \( F_p > \frac{5}{(2 \times .42)} = 6.0 \) pounds
- Dry skin: \( F_p > \frac{5}{(2 \times .27)} = 9.2 \) pounds

Coefficient of Friction

<table>
<thead>
<tr>
<th>Material</th>
<th>Dry (n=42)</th>
<th>Moist (n=42)</th>
<th>Combined (n=84)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Paper (#320)</td>
<td>--</td>
<td>--</td>
<td>0.61 ± 0.10</td>
</tr>
<tr>
<td>Smooth Vinyl</td>
<td>--</td>
<td>--</td>
<td>0.53 ± 0.18</td>
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<tr>
<td>Textured Vinyl</td>
<td>0.41 ± 0.10</td>
<td>0.66 ± 0.14</td>
<td>0.50 ± 0.11</td>
</tr>
<tr>
<td>Adhesive Tape</td>
<td>0.39 ± 0.06</td>
<td>0.66 ± 0.11</td>
<td>--</td>
</tr>
<tr>
<td>Suede</td>
<td>0.39 ± 0.06</td>
<td>0.66 ± 0.11</td>
<td>--</td>
</tr>
<tr>
<td>Aluminum</td>
<td>--</td>
<td>--</td>
<td>0.38 ± 0.13</td>
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<tr>
<td>Paper</td>
<td>0.27 ± 0.09</td>
<td>0.42 ± 0.07</td>
<td>--</td>
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</tbody>
</table>

**References**

Balance

Suspend Tool

Balancer & Torque Reaction Bar

Electromyography

EMG Analysis of Notebook Packing

EMG Amplitude Probability Distribution, APD


Force & EMG Recordings During Keying

APD Keyboard Work

Cumulative Frequency

% of MVC

Cumulative Frequency

% of MVC