Impact of work shift starting time on sleep patterns and alertness prior to injury in the People’s Republic of China

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Presenter Disclosures

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(1) The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

‘No relationships to disclose’

Mission:
To advance scientific knowledge in areas that can reduce injuries and ensure disability.
Study Objectives

- Early work shift start time and night shifts associated with reduced sleep duration, poorer sleep quality and increased fatigue (Härmä, 1993; Folkard & Lombardi., 2005; Willamson et al., 2011; Vetter et al., 2012, Judah et al., 2013)
- This study investigates the impact of work shift starting time on sleep duration, sleep quality, and alertness/sleepiness among:
  - A large epidemiological field study of hospitalized adults with severe work-related hand injury in the People’s Republic of China (PRC) (Jin, Lombardi et al., 2012; Lombardi, Jin et al., 2014)

Background – Injury in the PRC

- Recent study of 3479 frontline Chinese workers in 60 factories (2008–2009) reported highest risk factors for injury were: working >55 hours per week (OR = 1.64, 95% CI: 1.21–2.22) and high mental work stress (Yu et al., 2012)

Epidemiology of Hand Injuries in PRC
- accounts for ~54% of emergency dept. visits and 43% of hospital orthopedic visits

Work-related Trauma in PRC
- 43–90% of all hand injury visits work-related
- average hospital duration: 12–18 days
- and disability

Study Population*

- Workers admitted for treatment of sudden-onset, traumatic injury to the upper-extremity
  - 2 ½ year period from 11 hospitals in 3 industrial cities in the PRC, Ningbo, Wuxi and Liuzhou
  - Injuries: laceration, crush, avulsion, puncture, fracture, contusion, amputation & dislocation to fingers, hand & wrist
  - Exclusions: sprain, strain, needle-stick injuries, falls, burns

**Interview Procedure**

- Study approved by IRC of LMRIS, IRB of HSPH, FSPH
- 730 hospitalized workers screened by physicians and informed consent obtained
- 703 (96.4%) completed a face-to-face interview within 4 days of injury in a clinic using structured questionnaire in Chinese (cross-translated) by trained interviewers

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**Methods**

- For this analysis workers reported:
  - Injury date and time
  - Timing of work schedules and rest breaks
  - Sleep start and wake time (time before injury and two previous days)
  - Sleep quality (time before injury and two previous days); scale 1-10
  - Alertness/sleepiness (time of injury and two previous days) using the Karolinska Sleepiness Scale (1-9) (Akerstedt et al., 1990)

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**Methods – Statistical Analysis**

- **ANCOVA Model**
  - Dependent variables:
    - Sleep duration, Sleep quality
    - Alertness / sleepiness at the time of injury
    - Main effect: Work shift starting time (8 x 3h increments across the 24h day)
  - Covariates: age, gender, daily shift duration, workdays per week, day of injury and interactions, sleep quality, alertness / sleepiness
  - Test of interaction: Work shift starting time x gender
Demographics, Work Hours and Sleep

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Gender (N=703)</th>
<th>Occupation (top 3)</th>
<th>95% Confidence Interval</th>
<th>N</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male 527 (75.0)</td>
<td>Machinery mfg. 149 (25.0)</td>
<td></td>
<td>703</td>
<td>31.8</td>
<td>0.39</td>
<td>31.0</td>
<td>32.6</td>
</tr>
<tr>
<td></td>
<td>Female 176 (25.0)</td>
<td>Fabricated metal mfg. 110 (18.5)</td>
<td></td>
<td>703</td>
<td>9.5</td>
<td>0.08</td>
<td>9.3</td>
<td>9.7</td>
</tr>
<tr>
<td>Age</td>
<td>703</td>
<td>6.4</td>
<td>0.04</td>
<td>6.3</td>
<td>6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily shift duration (hrs.)</td>
<td>703</td>
<td>55.7</td>
<td>0.56</td>
<td>54.6</td>
<td>56.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days worked/week</td>
<td>703</td>
<td>0.8</td>
<td>0.04</td>
<td>0.8</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sleep duration (hrs., time before injury)</td>
<td>700</td>
<td>8.5</td>
<td>0.07</td>
<td>8.3</td>
<td>8.6</td>
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</table>

Shift and Sleep Times

<table>
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<tr>
<th>24-hour clock, local time</th>
<th>Shift Starting Time</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00 – 02:59</td>
<td>15</td>
<td>2.1</td>
<td>65.2</td>
</tr>
<tr>
<td>03:00 – 05:59</td>
<td>16</td>
<td>2.3</td>
<td>42.9</td>
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<tr>
<td>06:00 – 08:59</td>
<td>541</td>
<td>77.3</td>
<td>24</td>
</tr>
<tr>
<td>09:00 – 11:59</td>
<td>18</td>
<td>2.6</td>
<td>36.4</td>
</tr>
<tr>
<td>12:00 – 14:59</td>
<td>17</td>
<td>2.4</td>
<td>36.3</td>
</tr>
<tr>
<td>15:00 – 17:59</td>
<td>41</td>
<td>5.9</td>
<td>1.0</td>
</tr>
<tr>
<td>18:00 – 20:59</td>
<td>48</td>
<td>6.7</td>
<td>17.6</td>
</tr>
<tr>
<td>21:00 – 23:59</td>
<td>13</td>
<td>1.8</td>
<td>10.1</td>
</tr>
</tbody>
</table>

Mean (± 95% CI) Sleep Duration (night before injury) by Work Shift Starting Time (3 h categories)
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**ANCOVA Results**
Mean (±95% CI) Sleep Duration (night before injury) by Gender and Work Shift Starting Time

![Graph showing sleep duration by gender and shift start time]

Shift start time x Gender: F-value=7.23, p-value <0.0001

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**Sleep Quality (last sleep before injury) by Work Shift Starting Time (3 h categories)**

- No statistically significant difference across work shift start times for sleep quality

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**Karolinska Sleepiness Scores (KSS) (at time of injury) by Work Shift Starting Time (3 h categories)**

- Alertness/sleepiness based on the KSS (generally alert) did not vary significantly across shift starting times
Summary of Results

- Overall mean sleep duration shortest for workers starting shifts at "21:00-23:59" (5.6±0.8h), followed by midnight "00:00-02:59" (6.1±0.6h)
- Statistically significant interaction (p<0.05) between gender and work shift starting time on mean sleep duration:
  - Males: 5.8h at "21:00-23:59"
  - Females: 4.3h at "24:00-02:59" and "15:00-17:59"
- Sleep quality (generally quite well) and alertness / sleepiness based on the KSS (generally alert) did not vary significantly across shift starting time.

Discussion

- Self reported wake and sleep times, sleep quality, and alertness / sleepiness scores (recall bias)
- Subjects from case crossover study (within-person design), thus no controls which to compare our results
- Small sample sizes within work shift start time categories when stratified by gender

Limitations

- Short period between work injury and the follow-up interview of worker (median of four days)
- Workers hospitalized (confirmation of injury outcome)
- Heterogeneous group of occupations (external validity)

Strengths

- Consistent with findings from other countries:
  - Shortest sleep durations occur when work shifts start in early morning or late at night in the PRC
  - However, PRC workers on average in this study slept an average of 8.5h on workdays
  - Much longer than a typical US day worker who sleeps on average, 5.4h on workdays, 7.4h on free days
  - This may help to explain the higher than expected alertness / sleepiness KSS scores at the time of injury
The impact of shift curtail time on sleep duration, sleep quality, and accidents prior to injury in the People's Republic of China

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