THE EFFECT OF ACTIVE MOTION SITTING ON WORKER PRODUCTIVITY AND OCCUPATIONAL SEDENTARINESS

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Work Environment Impacts Health of Workers and is becoming Increasingly Sedentary

Sedentary jobs ↑ 83% since 1960

EE ↓ 100 kcals/day since 1960

Church et al., PloS One, 2011
Service Workers are Highly Sedentary while at Work

Parry and Straker, *BMC Public Health*, 2013
Sedentary behavior is an **INDEPENDENT** risk factor for adverse health and work outcomes

**Chronic Disease Risk**
- Mortality
- Cognitive function
- Mental distress
- Musculoskeletal disorders
- Work Productivity

- Hu FB., Lipids, 2003
- Voss et al., Mental Health & Physical Activity, 2014
- Hamer et al., MSSE, 2014.
- Mouchacca et al., BMC Public Health, 2013
Interrupting Sedentary Time Associated with Improved Health and Work Outcomes

Healy et al., *Diabetes Care*, 2008
Pronk et al., J Occup Enviro Med, 2004
... and interrupting Sedentary Time Improves Work Outcomes

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Dependent Variable</th>
<th>β-coefficient</th>
<th>(P) value</th>
<th>Interpretation of the Effect on Work Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate physical activity</td>
<td>Quality of work performed</td>
<td>0.0574</td>
<td>0.0017</td>
<td>Improvement</td>
</tr>
<tr>
<td>Moderate physical activity</td>
<td>Overall job performance</td>
<td>0.0517</td>
<td>0.0047</td>
<td>Improvement</td>
</tr>
<tr>
<td>Vigorous physical activity</td>
<td>Overall job performance</td>
<td>0.0538</td>
<td>0.0039</td>
<td>Improvement</td>
</tr>
<tr>
<td>Cardiorespiratory fitness (estimated VO2\text{max})</td>
<td>Quantity of work performed</td>
<td>0.0118</td>
<td>0.0454</td>
<td>Improvement</td>
</tr>
<tr>
<td>Cardiorespiratory fitness (estimated VO2\text{max})</td>
<td>Extra effort exerted</td>
<td>0.2098</td>
<td>0.0299</td>
<td>Improvement</td>
</tr>
<tr>
<td>BMI (obesity; \geq 30 and \leq 40 kg/m^2)</td>
<td>Getting along with coworkers</td>
<td>-0.239</td>
<td>0.0156</td>
<td>Decrement</td>
</tr>
<tr>
<td>BMI (severe obesity; \geq 40 kg/m^2)</td>
<td>Work loss days</td>
<td>1.0155</td>
<td>0.032</td>
<td>Decrement</td>
</tr>
</tbody>
</table>

* Only significant associations derived as a result of all regression analyses completed are presented in the Table; BMI, body mass index; analyses adjusted for age, sex, and education.

Healy et al., *Diabetes Care*, 2008
Pronk et al., J Occup Enviro Med, 2004
“Sedentary work tasks are a **hazardous exposure** which increases workers’ risk of adverse health outcomes and thus should be mitigated.”
Worksites have taken narrowly focused approach to advance health of workers

Health Promotion/Wellness
Promote lifestyle behaviors outside work that advance health

Health Safety/Protection
Reduce exposure to risk factors at work to protect health
Total Worker Health™
Total Worker Health™ Interventions

- Currently unclear whether integrated interventions are more effective than non-integrated interventions.
- Few TWH interventions have focused on needs of sedentary workers.

Anger et al., Occup Health Psychol, 2014
Sorensen et al., J Public Health Policy, 2003
Purpose and Hypothesis

To test the efficacy of an integrated TWH intervention against a non-integrated intervention on:

- Occupational sedentary behavior
- Occupational physical activity behavior
- Cardiometabolic health outcomes
- Work productivity
Step 1: Identify Source of Hazard
Step 2: Apply Engineering Controls to Mitigate Source of Hazard
Activity Permissive Workstations For Increasing Occupational Energy Expenditure

Tudor Locke Int J Obes (Lond) 2014
Measures

1. **Occupational sedentary/physical activity behavior**
   - GENEActiv monitor for 5 work days

2. **Cardiometabolic outcomes**
   - Weight, body composition, Resting heart rate, Blood Pressure, Waist Circumference, estimated cardiorespiratory fitness

3. **Work productivity**
   - WHO Health and Work Performance Questionnaire (HPQ)
Assessed for eligibility (n=145)

- Excluded (n=85)
  - Not meeting inclusion criteria (n=82)
  - Declined to participate (n=3)
  - Other reasons (n=0)

Randomized (n=60)

- Allocated to Integrated (n=30)
  - Received allocated intervention (n=30)
  - Did not receive allocated intervention (give reasons) (n=0)

- Allocated to Non-integrated (n=30)
  - Received allocated intervention (n=30)
  - Did not receive allocated intervention (give reasons) (n=0)

Follow-Up

- Lost to follow-up (did not complete) (n=2)
- Discontinued intervention (lost interest) (n=1)

- Lost to follow-up (did not complete) (n=3)
- Discontinued intervention (n=0)

Analysis

- Analysed (n=27)
  - Excluded from analysis (n=0)

- Analysed (n=27)
  - Excluded from analysis (n=0)
Participants

- 54 overweight (BMI>25.0 kg/m²), full-time (35 hrs/week) employees working in sedentary (sit >75% day) jobs
- Allocated to either:
  - Integrated Intervention (N=27)
  - Non-integrated Intervention (N=27)
Non-Integrated Group

30 minute Ergonomic Workstation Optimization Intervention at baseline

3 emails/week (16 weeks) reinforcing ergonomic evaluation messages
Integrated Intervention

- Self monitoring
- Goal setting
### Baseline characteristics between groups

<table>
<thead>
<tr>
<th></th>
<th>Non-Integrated (N=27)</th>
<th>Integrated (N=27)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>45.0±10.7</td>
<td>45.2±10.9</td>
<td>0.95</td>
</tr>
<tr>
<td>Female (%)</td>
<td>70.0</td>
<td>70.0</td>
<td>1.00</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168.6±7.9</td>
<td>169.0±11.1</td>
<td>0.84</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>206.4±29.6</td>
<td>215.9±42.7</td>
<td>0.18</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>33.0±5.6</td>
<td>34.5±6.8</td>
<td>0.23</td>
</tr>
<tr>
<td>Non-Hispanic (%)</td>
<td>100.0</td>
<td>100.0</td>
<td>1.00</td>
</tr>
<tr>
<td>White (%)</td>
<td>85.2</td>
<td>96.0</td>
<td>0.70</td>
</tr>
<tr>
<td>College Graduate (%)</td>
<td>81.0</td>
<td>67.0</td>
<td>0.36</td>
</tr>
<tr>
<td>Income &gt;$50,000 (%)</td>
<td>67.0</td>
<td>44.4</td>
<td>0.50</td>
</tr>
<tr>
<td>Years worked at current job</td>
<td>11.3±10.3</td>
<td>11.1±9.5</td>
<td>0.92</td>
</tr>
<tr>
<td>Average hours worked/week</td>
<td>38.1±6.7</td>
<td>40.8±5.4</td>
<td>0.13</td>
</tr>
</tbody>
</table>
## Occupational sedentary and physical activity

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Post-Intervention</th>
<th>Mean Difference a (95% CI)</th>
<th>Within Group P value</th>
<th>Group x Time Effect p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Physical Activity at Work (average counts/work day)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-integrated</td>
<td>91266(25098)</td>
<td>91124(25088)</td>
<td>-142 (-10623 to 10339)</td>
<td>0.98</td>
<td></td>
</tr>
<tr>
<td>Integrated</td>
<td>84665(20999)</td>
<td>94417(26556)</td>
<td>9751 (1067 to18436)</td>
<td>0.03*</td>
<td></td>
</tr>
<tr>
<td><strong>Percent Work Time Sedentary (% workday)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-integrated</td>
<td>86.0(4.4)</td>
<td>86.4(4.6)</td>
<td>0.4 (-1.0 to 1.8)</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Integrated</td>
<td>86.8(4.3)</td>
<td>84.8(5.9)</td>
<td>-2.0 (-4.4 to 0.3)</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td><strong>Percent Work Time in Light Intensity Physical Activity (% work day)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.04**</td>
</tr>
<tr>
<td>Non-integrated</td>
<td>4.7(2.8)</td>
<td>4.3(2.9)</td>
<td>-0.4 (-1.1 to 0.2)</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Integrated</td>
<td>4.2(1.5)</td>
<td>4.9(2.2)</td>
<td>0.7 (-0.2 to 1.7)</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td><strong>Percent Work Time in Moderate Intensity Physical Activity (% work day)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.38</td>
</tr>
<tr>
<td>Non-integrated</td>
<td>7.8(2.0)</td>
<td>7.9(2.2)</td>
<td>0.07 (-0.7 to 0.8)</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Integrated</td>
<td>8.0(3.4)</td>
<td>9.1(5.2)</td>
<td>1.1 (-1.1 to 3.2)</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td><strong>Percent Work Time in Vigorous Intensity Physical Activity (% work day)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.44</td>
</tr>
<tr>
<td>Non-integrated</td>
<td>1.5(1.0)</td>
<td>1.5(0.9)</td>
<td>-0.0 (-0.3 to 0.3)</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>Integrated</td>
<td>1.0(0.7)</td>
<td>1.3(0.7)</td>
<td>0.3 (-0.0 to 0.5)</td>
<td>0.10</td>
<td></td>
</tr>
</tbody>
</table>
Associations between active workstation adherence and changes in cardiometabolic and work productivity outcomes for integrated intervention completers (N=27).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Average Pedal Time/day (min)</th>
<th>Average # of Pedal Bouts/Day</th>
<th>Average Pedal Speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta Weight (lbs)</td>
<td>R= -0.41; p=0.04</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Delta Fat Mass (lbs)</td>
<td>R= -0.48; p=0.02</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Delta % Body Fat</td>
<td>R= -0.45; p=0.02</td>
<td>R= -0.41; p=0.04</td>
<td>--</td>
</tr>
<tr>
<td>Delta Resting Heart Rate (bpm)</td>
<td>R= -0.49; p=0.01</td>
<td>R= -0.45; p=0.02</td>
<td>--</td>
</tr>
<tr>
<td>Delta Waist Circumference (cm)</td>
<td>--</td>
<td>--</td>
<td>R= -0.48; p=0.02</td>
</tr>
<tr>
<td>Concentration while at work</td>
<td>R= 0.50; p=0.01</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Days missed due to physical/mental health past 4 weeks</td>
<td>R=-0.41; p=0.03</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
Average min pedaled/work day amongst Integrated Intervention completers (N=27)

Mean(SD) = 50.2(40.6) min/day ~ 107 kcals/day
Daily pedaling trends over 16 wks amongst Integrated Intervention completers (N=27)
Conclusions

- Integrated intervention increased occupational light intensity PA but did not improve cardiometabolic or work productivity outcomes
- Adherence → 50 min/work day → 107 kcals/day
- Trends hint at maintenance
- 70% employees elected to keep active workstation
- Better adherence associated with better health and work productivity outcomes
Future Work

- Long-term follow up to test maintenance & health effects
- Further explore impact on worker productivity, cognition, and state / trait worker affectivity.
- Further develop integration into business culture in various industries and company sizes.
- Use sensor based data to develop supportive integrated corporate wellness approach.
Acknowledgements

Our participants

ACT, Inc. and Sandy Stewart

Research Staff
McKenzie O’Neill
Alex Ferrer
Maggie Swift
Roberto Benzo
Sanjana Ramesh

Colleagues
Dr. Sharon Tucker, PhD
Dr. Nathan Fethke, PhD
Dr. Fred Gerr, MD
Dr. Christoph Leonhard, PhD

Funding Support
Healthier Workforce Center for Excellence (HWCE) at the University of Iowa. #No.U19OH008858; Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health