Sedentary Behavior in Office Environments

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Educational Background

- BS in Kinesiology/ Exercise Science 2006
  - Middle Tennessee State University
- MA in Experimental Psychology 2013
  - Middle Tennessee State University
  - Emphasis in Health & Wellness
- Doctoral Candidate Environmental & Occupational Health
  - Texas A&M University
  - Emphasis in Ergonomics, Human Factors, Health & Safety
Traditional Workstations

- Estimated most American adults spend 8-9 hours daily in sedentary behavior
- Increased health risks
  - Obesity, cancers, and cardiovascular disease
- Increased Body Discomfort
  - Low back, shoulder, and neck pain
- Decreased productivity

*Most common pain areas:
Neck 53%
Wrist 33%
Shoulder 38%
Low Back 63%*  
* Survey conducted by American Osteopathic Association
Health Impacts

- Prevalence of weight related risk factors
  - High blood pressures
  - High cholesterol
  - High blood sugar
- Increased diagnosis of type 2 diabetes
- Stroke
- Cancer
- Gallbladder disease
- Osteoarthritis
- Sleep apnea and asthma
Prevalence

- Percent of adults over the age of 20 who are overweight and obese\(^1\): 69%
- Percent of adolescents age 12-19 years of age obese\(^2\): 18.4%
- Percent of children 6-11 years of age who are obese\(^2\): 18%
- Percent of children 2-5 years of age who are obese\(^2\): 12.1%

\(^1\) Age-adjusted by the direct method to the year 2000 US Bureau of the Census using age groups 20-39, 40-59 and 60-74 years. Pregnant females excluded. \(^2\) Overweight defined as \(25 \leq \text{BMI} < 30\), obesity defines as \(\text{BMI} \geq 30\), Extreme obesity defines as \(\text{BMI} \geq 40\).
Obesity Costs

• Direct cost:
  • Estimated annual health care costs of $190 billion or nearly 21% of annual medical spending

• Indirect cost:
  • Obese employees miss more days from work
  • Obese employees work at less than full capacity
  • Higher rates of workers compensation payouts
  • Associated with lower wages and household income
  • Higher incidence of accidents for obese individuals
Sit-Stand Workstations

Pros:
• Increased health benefits
• Reduction in body discomfort
• Foot rails – increase body comfort

Cons:
• Expense: $250 - $1400 per desk
• Questions about sustainability and productivity performance
Hypothesis/Questions

Q. Does increased activity (standing while working) at work effect productivity?
• $H_0 =$ Increased activity at work increases productivity

Q. What is the impact of standing on cognitive performance?
• $H_0 =$ Standing while working increase cognitive performance

Q. Can behavioral interventions (computer prompts) increase and sustain sit-stand desk usage?
• $H_0 =$ Behavioral interventions increase and sustain sit-stand desk usage
Call Center Study
Productivity - Study

- 167 participants in a call center tracked for 6 months
- Treatment group
  - Stand-biased and mechanical sit-stand desks
- Control Group
  - Seated traditional desks
- Productivity measure
  - Successful calls per hour
Productivity Results

AVG Monthly Successful Encounters per Hour by Health Advisor

- Standing HC
- Sitting HC

February: 2.21 (Standing), 1.78 (Sitting)
March: 2.24 (Standing), 1.69 (Sitting)
April: 2.33 (Standing), 1.58 (Sitting)
May: 2.08 (Standing), 1.37 (Sitting)
June: 2.13 (Standing), 1.47 (Sitting)
July: 1.95 (Standing), 1.33 (Sitting)
August: 1.95 (Standing), 1.33 (Sitting)
September: 1.95 (Standing), 1.33 (Sitting)
Health Advisor Monthly Comparison

Stand Capable

226 calls per HA

Seated

133 calls per HA
Productivity Results – Clinical Advisor

AVG Monthly Successful Encounters per Hour by Clinical Advisor

Successful Encounters

Feb  | March | April | May  | June | July | August | Sep
1.5  | 1.45  | 1.61  | 1.55 | 1.49 | 1.41 |
1.18 | 1.07  | 1.05  | 0.88 | 0.87 | 0.86 |

Standing CA
Sitting CA
Clinical Advisors Monthly Comparison

Stand Capable: 161 calls per CA
Seated: 93 calls per CA
Productivity Results

- Control (Traditional seated desks)
- Intervention (stand-capable desks)

Mean successful encounter/hour

Month

March April May June July August
Key Results

• Treatment group
  • Self-reported seated 72% of day
  • Self-reported 75% reduction in body discomfort

• Control Group
  • Self-reported seated 91% of day

• Productivity measure
  • Overall 46% more productive per hour
  • Stand-capable increased 23% in first month to 53% over next 6 months
  • Increased productivity across both job categories
Task Performance & Cognitive Workload

Does standing while working effect cognitive performance?
Physical Activity

- Previous studies indicate cognitive processing speed influenced by changes in arousal state
- Studies specific to moderate/high intensity exercise
- Arousal states increase with physical exertion = improved cognitive performance

The Brain on Exercise

After 20 minutes of Sitting Quietly
After 20 minutes of Walking

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fNIRS (functional near infrared spectroscopy)

- fNIRS Measures brain activity based on refraction of infrared light to blood oxygenation levels
- Measured Pre-frontal Cortex Activation
  - 4 sources, 8 collectors
- Motion artifacts were corrected with a wavelet transformation
- Low pass filter removed systemic responses caused by heart beat
- Converted to Oxygenated (HbO) and Deoxygenated (HbR) hemoglobin concentration
- Computed mean HbO and HbR values across blocks
Cognitive Study

• 100 Texas A&M Student volunteers (ages 18-22)
• Randomly selected from 235 participant volunteers
• Measure prefrontal activation during cognitive computer task
  • N-back test – assessment that measures working memory
    • Reaction time and error rates
    • Performed standing and sitting (counter-balanced)
N-back Results

- **Reaction Time**
  - No significant difference in reaction times between sitting and standing conditions ($p = .327$)
  - Significant difference between genders. ($p = .003$)
    - Males .026 seconds faster than females in reaction times
  - No significant difference between age groups
  - Significant difference between order ($p = .011$)
    - First order .469 seconds slower regardless of condition

- **Error Rates**
  - No significant differences in error rates
    - Condition $p = .299$
    - Gender $p = .372$
    - Order $p = .138$
Cortical Arousal Levels – N-back Trials*

*Preliminary analysis. Collapsed across all conditions
Key Points

• No significant differences in performance between sitting and standing
• Standing arousal significantly higher for standing condition
• Chronic exposure may improve overall cognition = increased productivity
• Continued analysis to determine PFC affected areas
Behavioral Interventions

• Computer software
  • SitStand Coach
  • Prompts user to stand throughout the day
  • Tracks transitions hourly, weekly, monthly
  • Can run in the background to determine true desk usage
  • Tracks minutes standing/sitting
Study Protocol

- General office workers with electric sit-stand desks
- Baseline Period
  - 6-week “behind the scenes” monitoring to determine current sit-stand desk usage
  - Randomly assign half the participants to treatment group (receive prompts) or control group (do not receive prompts) based on location and floor – cluster randomized
- Experimental Period
  - 3 months of transitions
  - Prompting schedule was set at 6 min. standing for 30 min. sitting
- Surveys at 3 months post-intervention
  - Gender, age, ht., wt., current workstation setup, pre and post body discomfort, and views about software
- 200 participants completed both baseline and experimental phases
- Two geographically separate office complexes
Daily Usage

• Total active computer time between experimental and control groups were not significantly different.
• During the 3-month experimental period, experimental group stood on avg 42% more than control group.

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Mean Daily Standing Transitions by Month:

- **Control (No Prompts)**
- **Experimental (Prompts)**

![Graph showing mean daily standing transitions with error bars and significance markers.](image-url)
Monthly Transitions

![Graph showing mean daily standing transitions over months]

- **Control (No Prompts)**
- **Experimental (Prompts)**

The graph illustrates the trend in mean daily standing transitions from January to April. The experimental group shows a significant decrease in standing transitions compared to the control group, with a notable difference in February and March. The trend continues to show a decrease through April.
Pre and Post Transitions

Baseline

Intervention

Mean Daily Standing Transitions

Control

Experimental
Key Results – Experimental Group

• 40% of group adhered to the prompting schedule
• No rewards for increased transitions (following prompts)
• Group reported decreased body discomfort and increased focused as reasons to continue to use desk
• Took less than a week to habituate to standing at the desk
• Nearly 75% of the group indicated that continued use of the computer prompts was “probable” or “definite”

**More results coming soon**
Discussion

- Increased standing desk activity increases productivity
- Increased cortical arousal could mean increased cognitive behavior
- Use of computer prompting software increased use of sit-stand desks (behavior change)
- Small increase in standing time to realize benefits
  - Productivity study – Extra 75 min. per day
  - Cognitive study- no difference in standing time between groups
  - Behavioral study - ~14 min. standing additionally per day
Questions?