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Sedentariness at work; how much do we really sit?

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Abstract

Sedentariness is associated with obesity. We examined whether people with sedentary jobs are equally inactive during their work days and leisure days.

We enrolled 21 subjects of varying weight and body fat (11 M:10 F, 38 ± 8 years, 83 ± 17 kg, BMI 28 ± 5 kg/m^2, 29 ± 11 fat kg, 35 ± 9% fat). All subjects continued their usual work and leisure-time activities whilst we measured daily activity and body postures for 10 days.

The data supported our hypothesis that people sit more at work compared to leisure (597 ± 122 min/day c.f. 484 ± 83 min/day; P<0.0001). The mean difference was, 110 ± 99 min/day. Similarly, work days were associated with less standing (341 ± 97 min/day; P=0.002) than leisure days (417 ± 101 min/day). Although the walking bouts did not differ significantly between work and leisure (46 ± 9 vs. 42 ± 9 walking bouts/day); the mean free-living velocity of a walk at work was 1.08 ± 0.28 mph and on leisure days was 0.94 ± 0.24 mph (P=0.03) and the average time spent walking was 322 ± 91 minutes on work days and 380 ± 108 minutes on leisure days (P=0.03). Estimates of the daily energetic cost of walking approximated, 527 ± 220 kcal/day for work days and 586 ± 326 kcal/day for leisure days (r=0.72, P<0.001).

Work days are associated with more sitting and less walking/standing time than leisure days. We suggest a need to develop approaches to free people from their chairs and render them more active.

Keywords

Non-exercise activity thermogenesis; work; energy expenditure; movement

INTRODUCTION

Physical activity and nutrition are important in the pathogenesis, prevention and treatment of obesity (1;2). Posture allocation has been shown to be an important determinant of a person's non-exercise activity thermogenesis (3). Obese individuals, in particular, are seated 2 1/2 hours per day greater than lean individuals and as a consequence their non-exercise activity thermogenesis is low (4). In developed countries, the predominant mode of working is computer-based (5) and as a result many people spend their work-day seated (6). The purpose of this study is to examine the role of work on sedentariness; this area may be important for

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The authors declared no conflict of interest.

DISCLOSURE

None of the authors have any potential conflict of interest to disclose. Dr Levine provides gratis scientific advice to Muve Incorporated, in which Mayo Clinic owns equity. The Mayo Clinic and/or Dr Levine, may, in future derive royalties from this relationship. Muve Inc. provides wellness solutions to individuals and companies. The technologies and approaches used by Muve are NOT described in this manuscript.

understanding how best to reverse inactivity and obesity. Here we address the hypothesis that daily sitting time is greater on work days compared to leisure (non-work) days.

METHODS AND PROCEDURES

Subjects and Methods

Subjects—Healthy weight-stable volunteers were recruited through advertisements in the local newspaper and internal Mayo Clinic flyers. (n=21; 11 M: 10 F, 38 ± 8 yr, 83 ± 17 kg). Occupations were reviewed by a panel of five who were blinded to the data and the intentions of the study. Qualified panel members were familiar with the job titles and the work required of individuals with that job title. The panel defined the activity status of the jobs, as (7):

- “Entirely Sedentary”: chair-bound most of the day.
- “Semi-Sedentary”: intermittently standing and chair-bound but without substantial walking or physical labor.
- “Active”: substantially mobile with some physical labor.
- “Very-Active”: predominantly manual labor most of the day.

Study design—Free-living subjects were studied for 20 days. Volunteers were fed from our metabolic kitchen to maintain steady-state body weight (4) and instructed to continue usual daily activities.

For the last 10 days of weight maintenance feeding, subjects wore a validated Physical Activity Monitoring System (PAMS) to measure non-exercise activity (4). PAMS comprises four inclinometers and two triaxial accelerometers that are attached to the torso, thigh and trunk using unique undergarments.

Body fat was measured in duplicate using Dual X-ray Absorptiometry (DXA) (Lunar, Madison, WI) (4). Basal metabolic rate (BMR) was measured on three consecutive mornings (4). Mayo Clinic IRB approved the study and written informed consent was obtained.

Data and statistical analyses—For any 1/2 second, one of three postures could be defined:

- Chest sensors = vertical and thigh sensors = horizontal - the person was sitting.
- Chest and the thigh sensors = horizontal - the person was lying.
- Chest and the thigh sensors = vertical - the person was standing or walking

Standing was distinguished from walking using the vertical movement of walking. To address the primary hypotheses that sitting time was different between work and leisure days, a paired, 2-tailed t-test was used with significance defined as, $P<0.05$.

RESULTS

The subjects (9 obese, 11 lean, 1 overweight; 28 ± 5 kg/m^2; 29 ± 11 kg body fat, 35 ± 9% body fat) continued their usual activities throughout the duration of the protocol. Of the 21 subjects, one identified herself as Black and another identified himself as Asian. The remaining subjects were Caucasian (n=11) or designated themselves as unknown/other. The 210 days the 21 subjects wore PAMSs were classified as work and leisure days (129 work days and 75 leisure days), with a total of 6 days (3%) omitted due to incomplete work shifts. Each day analyzed represents 172,800 lines of data (since data are collated each half second). Since data were gathered for ten axes, the total data set was comprised of 352,512,000 discrete movements. There was the expected positive relationship between fat-free mass and BMR (r^2 =0.84).

Considering the limited size of the study, the 21 subjects were broadly representative of office workers; 14 of the jobs were, “Entirely Sedentary” and seven were “Semi-Sedentary”.

The data supported our hypothesis that subjects sit more on work days than leisure days (Figure). At work people sat longer compared to leisure days (597 ± 122 min/day c.f. 484 ± 83 min day; P<0.0001). The mean difference in sitting time between work days and leisure days was 110 ± 99 min/day. Leisure days were associated with more standing and walking (417 ± 101 min/day) compared to work days (341 ± 97 min/day; P=0.002). The average difference in standing and walking time between work and leisure days was, 76 ± 96 minutes. Thus, work is associated with more sitting time and less walking/standing time compared to leisure days.

Since leisure days were associated with more standing and walking time than work days, it might be expected that the subjects move more on leisure days. However, these data do NOT suggest that to be the case. We compared daily movement (from the accelerometers) between the subjects while they were at work and at leisure. We found that total daily acceleration was similar between work days (3811 ± 767 AU/day) and leisure days (3938 ± 877 AU/day) (the data were gathered in duplicate with 99% concordance). We plotted individuals’ daily acceleration for work and leisure days. We found that there was a positive within subject correlation (r = 0.66; P<0.001), suggesting that subjects who were more active during work days, were also more active on leisure days.

To estimate the energetic implications of our findings, we examined all the walks that people took; (validated in, (8)). Comparing work days to leisure days, the number of walking bouts did not differ significantly (46 ± 9 vs. 42 ± 9 walking bouts/day). On work days, the mean free-living velocity of a walk was 1.08 ± 0.28 mph and on leisure days was 0.94 ± 0.24 mph (P=0.03). The average time spent walking was 322 ± 91 minutes on work days and 380 ± 108 minutes on leisure days (P=0.03). Estimates (validated in, (9;10)) of the daily energetic cost of walking approximated, 527 ± 220 kcal/day for work days and 586 ± 326 kcal/day for leisure days (r=0.72, P<0.001).

Although gender-specific differences were not the principal focus of this paper, we compared posture allocation for men and women. There were no significant differences between men and women (work day sitting time for men 623 + 111 min/day min/day and women, 568 + 138 min/day and leisure day sitting time for men, 491 + 84 min/day cf women, 476 + 98 min/day). The data for the obese (n=9; 5 M:4 F, 39 ± 5 yr, 33 ± 1.8 kg/m^2, 98 ± 11 kg) and lean (n=11, 6 M:5 F, 36 ± 10 yr, 24 ± 0.9 kg/m^2, 71 ± 9.5 kg) subjects were also compared. In both groups, work days were associated with significantly greater sitting time compared to leisure days. For the obese subjects, standing & walking time was 80 + 73 minutes greater than for work days (P=0.01). For the lean subjects, standing & walking time was 83 ± 113 minutes greater than for work days (P=0.04). The converse was true for sitting. The differences between work and leisure days were not accounted for by obesity. Thus lean and obese people show similar quantitative differences between work and leisure days.

DISCUSSION

Sedentariness has been associated with obesity (11). Since most people in high-income countries are employed, workplace physical activity represents a potentially important opportunity to help reverse inactivity and obesity. Using carefully validated equipment, we found that work days are associated with two hours more sitting and less standing & walking time than leisure days. Moreover, ‘active people’ consistently have high-activity jobs plus highly active leisure and could expend several hundred kcal/day more through walking than inactive people.

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Our studies, although detailed, were limited especially by sample size. However, the study was adequately powered to address our primary and secondary hypotheses and the study population was broadly representative of a modern office work force; larger-scale studies are urgently required.

These findings pose questions which are not mutually exclusive; do implicitly active people (12-14) select active jobs and hence have high leisure activity? Or is it that inactive jobs beget slothfulness at home? If the former is true; further biological insight is need to redress obesity. If the latter is true; mass-scalable weight loss solutions and redesign of work (and possibly schools (6;15)) should be examined.

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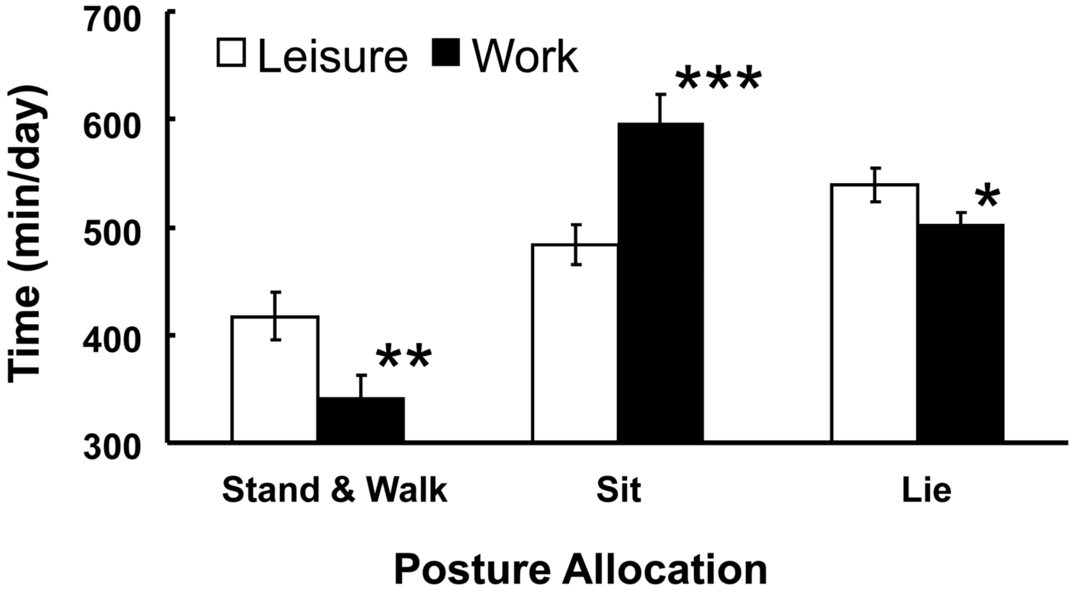

Figure.

Posture allocation per day for 21 subjects. Values are presented as means ± standard error of the mean (ANOVA and post hoc paired t-tests; * p=0.02, ** p = 0.004, ***p = 0.0001).