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A FIELD EXPERIMENT

Avner Ben-Ner, Darla Flint Paulson, Gabriel Koepp, James Levine

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The Effects of Walking while Working on Productivity and Health:

A Field Experiment

Avner Ben-Ner,[1] Darla Flint Paulson,[2] Gabriel Koepp[3] and James Levine[3]

May 2012

Abstract

Lack of physical activity can cause health problems and diminish organizational productivity. We conducted a 12-months long field experiment in a financial services company to study the effects of slow-moving treadmills outfitted for office work on employee productivity and health. 43 sedentary volunteers were assigned randomly to two groups to receive treadmill workstations 7 months apart. Employees could opt at will for standard chair-desk arrangement. Biometric measurements were taken quarterly and weekly online performance surveys were administered to study participants and to more than 200 non-participants and their supervisors.

In this study we explore three questions concerning the effects of the introduction of treadmills in the workplace. (1) Does it improve overall physical activity? (2) Does it improve health measures? (3) Does it improve performance?

The answers are as follows. (1) Yes (net effect of almost half an hour a day). (2) Yes (small gains, one minor decline). (3) No and yes (initial decline followed by increase to recover to initial level within one year) – based on weekly employee self reports.

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The Effects of Walking while Working on Productivity and Health:

A Field Experiment

Sedentariness and general physical inactivity cause or aggravate, for most people, a myriad physical illnesses (WHO, 2002), obesity (Mummery et al., 2005) and psychological problems (Brownell, 1995; Hughes et al., 2007). In addition, obesity and related negative health outcomes increase health care costs (Aldana, 2001; Golaszewski, 2001) and reduce worker performance (Ricci and Chee, 2005; Bates et al., 2008; Goetzel et al., 2010). Conversely, the effect of physical activity on health is unequivocally positive for all levels of intensity and duration; the greatest health improvements due to additional activity occur among individuals who have the lowest baseline levels of physical activity (Powell, Paluch and Blair 2011).

There is therefore an individual and public interest in engaging greater numbers of people in physical activity. Alas, physical activity is not a free good: it frequently costs time and money, and for most people it is probably a source of direct disutility. Because of a combination of ignorance, preferences, externalities and unrealistically high time discount rates, most individuals engage in a level of physical activity below that deemed by many observers as individually and socially optimal.

Physical activity may be part of normal daily activities as a natural by-product of other activities and at no additional cost, such as physical work, walking to get to places, and doing house chores, but familiar technologies have diminished substantially these activities (Lakdawalla, Philipson and Bhattacharya, 2005). To compensate for this trend, or for the mere positive utility they derive, some people exercise, cycle to work, walk the dog, use push lawn mowers and use stairs voluntarily, sometimes at a cost of money and/or leisure time. But these people represent a small minority in the general population and additional and diverse steps are needed to increase the level of physical activity of a large proportion of the population.

One potential approach to induce more people to increase their physical activity is to reduce its relative price. There are many ways of accomplishing that. Providing incentives to exercise in the expectation of forming habits that allow for removal of the incentives proves to be effective, albeit for few people only (Charness & Gneezy 2009). Making it easier to walk and bike by creating special lanes or paths has had a small impact of the physical activity of residents

(Hoener et al., 2005), and making it costlier to drive (e.g., imposing high fees on car access to the central business district, as in London), has also reportedly had a positive, albeit small, impact on physical activity. The majority of public health and employer-sponsored initiatives to date have been of this type.

Recent research has suggested that the decrease in physical activity at work may have been a more substantial contributor to the obesity epidemic than leisure time activities (Church et al., 2011). Some researchers have shown that simple interventions to increase activity at work – recommendation for walking stairs, standing up occasionally, walking during breaks, etc. – do result in increased physical activity (Emmons,1999; WHO, 2002).

The effects of physical activity on employee productivity are less clear-cut. Bernaards, Proper & Hildebrandt (2007) found no association between self-reported physical fitness and work productivity. Pronk et al. (2004) found a positive association between physical activity and quality and quantity of performance. Tompa (2002) reviews several studies suggesting fitness intervention programs decreased sickness absence. Coulson et al. (2008), the first study using a within-person experimental design, found that employees' self-rated job performance and mood was higher on the days they exercised in the company gym than on days they did not.

Since the problem of lack of physical activity is closely associated with sedentariness at work, an obvious fix is to increase activity there not by cutting work hours to allow employees to go to the gym but incorporating activity into sedentary jobs. This could be accomplished by getting the work done while walking. Of course, few jobs can be done "on-the-go" and few workplaces can afford to center their activities on indoor running tracks. But if one cannot take employees to the track, one can bring treadmills to many employees. We conducted a longitudinal field experiment to examine two principal questions: would the availability of treadmill work stations enhance employee health, and would treadmills be detrimental to employee performance? After all, management would have difficulty instituting treadmill workstations if this harmed productivity (unless gains in health and reduction in employer health care costs offset performance losses). The experiment was carried out in a financial services company and consisted of provision to employees of slow-moving treadmills outfitted for office work, the speed of which they could control (0-2 mph). Usage of treadmills by the 40 employees who volunteered to participate in the study was optional, and there was no monitoring by the employer of how much employees walked. The opportunity to volunteer to participate in a year-long study was offered by the company to nearly 400 employees; participation was restricted to 40 participants. The participants were divided randomly into two groups, with the treatment group receiving treadmills at the start of the experiment. After seven months the control group also received treadmills, and both groups continued to have treadmills for another five months. At the start of the experiment participants in both groups were outfitted with an energy monitoring device that was worn continuously (except while sleeping and showering). Also, they were administered a quarterly health test. Concurrent with the field experiment, all employees, both participants and non-participants, were asked to complete on-line detailed quarterly surveys and brief weekly three-minute surveys. Supervisors were asked to complete similar surveys about the performance of all of their supervisees.

The paper makes several contributions to the understanding of the linkages between low to moderate levels of physical activity and health and especially workplace outcomes. First, we conduct a novel workplace intervention, walking while working, heeding the call by several researchers to find practical interventions that involve the workplace (Engbers et al., 2005). Second, this is a year-long longitudinal study that allows us to investigate effects that may not be immediate or may be even changing sign over time. Third, we use longitudinal objective biometric measures of employee health. Fourth, we rely on multiple self- (employee) and other-reports (supervisor) of work performance. These and other behavioral variables are reported weekly, right after they occur, decreasing bias due to faulty memories that plague studies asking for recall over a longer time frame. Fifth, participants' subjective measures of physical activity are complemented by data from a continuously-worn activity monitoring device.

Using the quarterly biophysical and work performance measures we carried out difference-in-differences analyses comparing pre-study, 7 and 12 months levels for treatment and control groups. Many but not all biophysical health measures improved for the treatment group relative to the control group after the introduction of treadmill workstations. Using the weekly performance data from the online surveys, we found that performance declines initially but eventually turns around and ultimately exceeds pre-experiment levels (but just missed by the before/after analysis). These trends are statistically and economically significant.

The paper is structured as follows. In the next section we build, on the basis of extant literature, a simple conceptual framework to generate hypotheses about the effects of the introduction of treadmills as an optional workstation on physical well-being and work performance. In section 2, we describe in detail the study and the data we collected. Section 3 presents the details of the analysis and the findings, and section 4 concludes the paper.

1. Conceptual framework and relevant literature

Workplace interventions intended to enhance fitness have been shown to increase physical activity and to reduce body fat (Proper et al., 2002; Abrahama and Graham-Rowea, 2009; Groeneveld et al., 2010; Verweij et al., 2010). However, some studies fail to show that the intervention increases physical activity (e.g., Jago et al., 2011), and for most biometric health outcomes, the evidence is less conclusive if they are studied at all (Proper et al., 2002; Proper et al., 2005; for a disagreeing perspective, see WHO, 2009). Empirical studies in this area are generally difficult to interpret because they often lack randomization and longitudinal designs (Dishman et al., 1998; Proper, 2008), though some of the more recent studies incorporate these features and have more positive results (e.g., Bertheussen et al., 2011). No previous studies test workplace interventions involving walking while working.

In this section we develop a conceptual framework that focuses on the effects of the introduction of working while walking – henceforth WWW – on the health and productivity of sedentary workers. The workers in our company carry out a variable mix of routine manual tasks and moderately complex cognitive tasks such as typing information on a keyboard, taking written notes in longhand, answering and initiating phone calls with customers and coworkers, defining problems and identifying solutions to them, and participating in face-to-face meetings with coworkers and superiors. The low speed of walking, up to 2 miles per hour (when workers choose to walk instead of standing or sitting) entails a moderate physical effort, and represents a completely new experience for the vast majority of workers. The treadmill workstation, pictured below, is described in Koepp et al. (2011).

– Insert treadmill image –

a. WWW effects on physical activity and health

Our main objective in this subsection is to establish the effect of the introduction of treadmills in the workplace on movement and other forms of physical activity at work and after work. We then claim, based on the medical literature, that if total movement increases, health outcomes will improve. In the empirical section we test separately the impact of WWW on physical activity and on health outcomes.

Consider an individual who allocates his or her daily time among sedentary, moderate and active physical activities. The allocation does not affect the individual's income, so it is based on the individual's disposition and habits (preferences) and the relative "prices." These prices reflect ease of access to activities, comfort while carrying out activities, social pressure to be involved in physical activities, physical ability to carry out activities, and so on. So a change in the level of activity (e.g., from sedentary to moderate or to active) may be the result of a change in preferences or in relative prices. We examine the effect of WWW on movement in the absence of mandatory use and monitoring in light of this framework that distinguishes between changes in prices and in preferences.

The ready availability of a treadmill lowers the cost of engaging in physical activity, as walking is concurrent with completing work tasks and requires no travel. The presence of the treadmill is also sending the individual a reminder to engage in physical activity; experiments have shown that reminders to exercise contribute to greater physical activity (Goldhaber-Fiebert, Blumenkranz and Garber, 2011). However, the novelty of WWW may wear out as the treadmill becomes an ordinary component in one's office, much the same way that the presence of exercise equipment in the home may nudge a person to work out initially, but over time the individual doesn't think about the equipment when viewing it (or uses it as a clothes hanger). Hence this particular effect may weaken over time.

Inactive and unfit individuals have high costs (real or perceived) costs of exercise, so the introduction of WWW will be more effective for them than for those who arrive. Individuals who increase the level of their activity due to WWW will experience fitness gains, which may make it easier to walk more on the treadmill and engage in physical activity also after work, leading to even greater activity over time. On the other hand, already-active individuals may regard WWW as a substitute for exercise, in which case the net effect on movement depends crucially on the nature and size of the substitution effect.

Volunteering to participate in the study may act as a self-commitment device to exercise (Goldhaber-Fiebert, Blumenkranz and Garber, 2011). Furthermore, the company made available expensive treadmills and reconfigured offices, which may put the onus on participating employees to reciprocate by using the equipment.

Engaging regularly in an activity may be habit-forming in the sense that past behavior changes future consumption (Becker and Murphy, 1988). Charness and Gneezy (2009) tested the conjecture that incentives can be used to form positive habits in an experiment where individuals were paid to exercise. They found that some individuals who were previously inactive continued to exercise after the payments stopped. Likewise, WWW may help change habits in non-work situations; for example, talking on the phone while walking on the treadmill may habituate to walk while talking on the phone, which may increase the total physical activity of an individual.

In sum, we expect that the changes in relative prices and in preferences will favor an increase in physical activities and a concomitant decline in sedentary activities. On the basis of the discussion and this conclusion we specify the following complementary hypotheses:

H1. The introduction of WWW improves physical activity.

On the basis of this hypothesis and the fact that greater physical activity is positively (certainly not negatively) related to health (Bertheussen, 2011), we expect WWW to have a positive effect on health outcomes. However, the effects may take a long time to materialize because of the limited intensity of the physical effort associated with slow walking; some biometric measures may respond faster than others.[1] Furthermore, some individuals may change their diet as they start walking on the treadmill.[2] We offer a general hypothesis that reflects the current medical consensus:

H2. The introduction of WWW has a positive effect on health measures.

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[1] Just how much physical activity is required has not been established yet. Reynolds (2012) in her review of the research quotes from the U.S. Department of Health and Human Services 2008 *Physical Activity Guidelines for Americans* (itself containing a detailed review of the literature): the "amount of physical activity necessary to produce health benefits cannot yet be identified with a high degree of precision" (http://www.health.gov/paguidelines/). However, the report recommends 150 minutes of moderate activity, such as walking, as the gateway to improved health – hence the title of Reynolds' book.

[2] The specific responses depend on an individual's physiological and psychological profile, such that some may improve their diet as part of a health-enhancing life style while others may reward themselves with additional food or sweets.

We conjecture that the effects specified in these hypotheses occur within a matter of months, but do not offer a specific time frame because the literature does not provide enough guidance on this matter.

b. WWW effects on performance

WWW is an instance of multitasking: walking while carrying out other tasks (typing, writing, reading, speaking, and thinking). As with other forms of multitasking, there are two possible interactions between walking and diverse tasks: rivalry and complementarity. Walking is rivalrous and a hindrance to tasks that require a steady posture and the use of hands for precise execution; (Straker, Levine and Campbell (2009) find that walking on a treadmill has a negative impact on keyboard and mouse performance).

On the other hand, walking reduces stress, increases the size of the hippocampus and improves memory (Erickson et al., 2011), and therefore may improve execution of complex cognitive tasks (Falkenberg, 1987).[3] Walking, like other routine activities such as knitting that are not related to the cognitive tasks, may also help with focus and concentration on work-related cognitive tasks.

Thus WWW will have mixed effects on job performance, depending on the mix of tasks. However, the implementation of WWW does not have to be rigid, such as maintaining a steady speed. In the present study, employees have discretion to adjust the treadmill speed as they see fit, from 0 mph (standing or sitting) to 2 mph; it is hard to imagine an implementation of WWW without this feature. Thus employees can optimize the speed relative to the task at hand, for example standing or sitting still when typing, walking very slowly when talking on the phone and taking hand-written notes, and walking faster when thinking about complex problems. Learning how to perform various tasks may take time, however.

WWW also impact performance also via health improvements. We argued that WWW will improve an employee’s health and ability to handle stress, reducing the negative effect of stress on performance. High stress decreases productivity, and increases turnover, absenteeism and accidents (Falkenberg, 1987). Conversely, physical and emotional well-being enhances job performance (Puterman et al., 2010). WWW may also enhance employee performance as

[3] It is not clear, though, whether walking *while working* will have these effects on cognitive abilities; these studies were in other contexts.

employees who receive treadmills reciprocate the employer's unconditional gift (e.g., Fehr and Gaechter, 2000).

Employees may require some time to learn how best to carry out their various work tasks in combination with walking on the treadmill. There will likely be a period of learning and experimentation during which performance will decline, but subsequently performance will reach the pre-WWW level and probably exceed it. It is difficult to predict the duration of the learning period and transitioning from a life-long desk-and-chair way of working to a partly walking, partly standing and partly sitting way of working. For example, learning how to drive a vehicle takes several months for most individuals.[4]

On the basis of the discussion above we formulate our key performance-related hypotheses.

H3.WWW users' performance will decline immediately following its introduction but after a period of adjustment and learning it will rise above the pre-WWW level.

2. Experimental Design and Data

To test these hypotheses we developed a field experiment. Our principal empirical objectives have been to evaluate the relationship between the introduction of WWW and changes in (1) employee health, and (2) employee performance.

A national financial services company agreed to be the site of the experiment. The experiment involved refitting the standard office layout with a workstation where the computer, phone and writing space can be elevated in front of a treadmill, or lowered with the treadmill becoming a stable platform for a chair. The treadmill could be operated by the employee at speeds between 0 and 2 mph. There was no stated or implied expectation that employees walk a certain part of the time. All study participants were promised that data collected in relation to the experiment were to be kept anonymous and the employer will receive only statistical analyses that preserve employees' anonymity, including regarding the amount of time an employee used a treadmill.

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[4] Hence, *if* the worker (1) understands the relationship between WWW and performance, and (2) seeks to maximize performance, then performance cannot deteriorate under WWW on the long run. If the worker does not care about performance and his or her performance is not monitored, then the opportunity to use the treadmill to exercise on the job will be detrimental to performance; however, this scenario is unrealistic because before the introduction of treadmills employees could have found other ways to shirk. If they did, the treadmill would represent an opportunity to shift the form of shirking rather than its extent.

Of the 409 people invited, 43 people volunteered to be a part of the study. The first 40 volunteers were randomly assigned to two groups with 20 each. Members of the treatment group received treadmills in June 2008 and are referred heretofore as Walker 1. Members of the control group received treadmills in late December 2009 and are referred to as Walker 2.[5] The experiment ended as planned after 12 months, at the end of May 2009. Four treatment participants dropped out from the study, but no one dropped out of the control group.[6] The remaining company employees never received treadmills and constitute the non-walker control group and who, along with Walker 1 and Walker 2, participated in the longitudinal survey portion of the study.

a. Data collection methods and sources

The data were collected through medical testing and surveys, and from company administrative records. Both Walker 1 and Walker 2 participants were outfitted in May 2008 with an accelerometer, which is an energy expenditure monitoring device that was worn continuously, except while sleeping, showering or swimming. The device, licensed by Gruve of Minneapolis, MN and manufactured by Respironics of Bend, OR, is similar to familiar devices that measure the number of steps taken and the speed of walking (see Photograph 1). The device is a tri-axial accelerometer worn on an elastic belt positioned on the right hip of the participant. It measures the quantity and magnitude of movements captured at 32 Hz. The measurements were converted into speed of walking using a proprietary formula generated by the device manufacturer.

– Insert accelerometer image –

Participants were administered various medical tests on a quarterly basis. All employees – participants and non-participants – were administered two types of online surveys. The first type was an extensive quarterly questionnaire concerning work, life and health, and was administered in May 2008, just before the start of the experiment, in September 2008 and January 2009, and

[5] The remaining three volunteers were waitlisted but ultimately included with the control group, receiving treadmills at the same time as the Walker 2 group as a few volunteers in the Walker 1 group dropped out of the study..

[6] One employee dropped out of the study because she was pregnant; the other three dropped out of the study because they didn't want the treadmills in their offices. All dropouts occurred after the first quarterly report, so the first analysis of quarterly performance, from May-September, was not affected by attrition. The waitlisted employees joined the Walker 2 group.

immediately after the study ended, in May. In addition, a three-minute survey was administered to all employees every non-holiday Wednesday. All supervisors received both the quarterly long surveys and the three minute weekly surveys focusing on each of their supervisees, concentrating on key questions that paralleled the work-related questions asked of the supervisees. Each supervisor had on average 10 supervisees. (Supervisors filled out surveys also as employees). In total we administered the weekly surveys 50 times and the quarterly surveys four times.[7]

The company allowed all employees to fill out the surveys on company time, and gave participants a small incentive to participate, in the form of personal time, based on our quarterly reports of participation in the survey. As with most longitudinal surveys, our response rates declined over time. For the baseline survey, the employee response rate was 54%, for the September survey it was 42%, for the January survey it was 39% and for the final survey it was 38%. Corresponding response rates for the supervisor portion of the survey were 72%, 49%, 39% and 40.0%. The weekly employee survey response rates averaged 37% (range 30-50%), and the supervisor surveys averaged 43% (range 33-61%).

The data sources described above are summarized in Table 1 by the broad classes of variables and the different groups to which they pertain.

– Insert Table 1 –

b. Measures

Table 2 presents the variables and descriptive statistics separately for Walker 1, Walker 2 and Non-Walker. We start with a discussion of the two sets of dependent variables, those that pertain to employee health and those that reflect employee performance.

- Insert Table 2 –

Employee health. Theses measures, obtained by medical staff for Walker 1 and Walker 2, include weight, the percentage of body fat, triglycerides, HDL and LDL cholesterol, thyroid stimulating hormone (TSH, related to metabolic rate), waist circumference and systolic and

[7] Changes in the company workforce – separations, hires, moves within the company and promotions to supervisory roles – were reported to us immediately and were reflected in the type of survey affected employees received and were accounted for in our analyses.

diastolic blood pressure. Accepted medical wisdom is that lower values for these measures are better for most individuals, with the exception of HDL ("good") cholesterol. We use the employee's initial BMI, based on survey information, to test for selection effects and in moderator analysis.

Employee performance. The performance measures, similar to those employed by Pronk et al. (2004), were obtained through survey questions addressed to employees and their supervisors. The questions to the two groups were nearly identical. Overall performance was assessed overall for the previous week;[8] quality of performance,[9] quantity of performance[10] and quality of interactions with coworkers[11] were assessed for the previous two days during the weekly surveys. The quarterly surveys asked employees and their immediate supervisors to rate the employees' overall performance during the past four months. These items were discussed with the company's management, who agreed that they capture critical dimensions of performance that are used for performance evaluation and are comparable over time and across jobs.

We employ a number of independent variables that reflect different aspects of WWW and several variables that capture health-related conditions and activities of participants before they enrolled in the study, workplace characteristics, changes in the workplace and other factors that may plausibly enhance or reduce the effect of WWW on outcomes.

Treadmill workstation. The presence of a treadmill in an employee's office is a necessary, but not sufficient, for actual walking-while-working to occur. The availability of a treadmill in the a study participant's office (in a particular week, our main time period) is therefore our first measure of WW. A related measure is the number of weeks the treadmill was available to an employee (and its squared value), which will help identify the role of learning over time.

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[8] On the employee survey the item is "On a scale from 0 to 10 where 0 is the worst job performance anyone could have at your job and 10 is the performance of a top worker, how would you rate your usual job performance during the past week?" On the supervisor survey the item is "Consider this employee's work on Monday and yesterday, Tuesday. Please rate the quality of this employee's work."

[9] Average of: "Consider your work yesterday, Tuesday. Please rate the quality of your work." and "Now consider the day before that, Monday. Please rate the quality of your work." Scored from 1 (Poor) to 5 (Far above average).

[10] Average of: "Consider your work yesterday, Tuesday. Please rate the quantity of your work." and "Now consider the day before that, Monday. Please rate the quantity of your work." Scored from 1 (Poor) to 5 (Far above average).

[11] Average of: "Consider your work yesterday, Tuesday. Please rate the quantity of your work." and "Now consider the day before that, Monday. Please rate the quantity of your work." Scored from 1 (Poor) to 5 (Far above average).

Physical activity of participants The principal measure of study participants' physical activity comes from the accelerometer. The energy data collected were converted into speed-of-walking equivalents, using a formula provided by the supplier of the accelerometer. We created three categories of intensity of physical activity: *sedentary*, equivalent to walking at a speed of less than 1 mph, *moderate*, equivalent to a speed of 1-2 mph, and *active*, equivalent to a speed higher than 2 mph. The physical activity underlying the energy expenditure measurements does not have to be only walking on the treadmill, but includes sleeping, sitting, climbing stairs, running, and so on.[12]

Weekend exercise and TV viewing – participants and other employees. We use the number of weekend hours spent exercising[13] each week and a comparable measure pre-WWW. As a principal measure of sedentary activity we use the hours of television viewing in the past four days (Saturday – Tuesday).[14]

Task and work environment measures and employee characteristics. We used the supervisor's report of the extent of their employees' task complexity and routine in moderator analysis. We also used the number of hours that the employee works on the computer each day in moderator analysis, taken from the employee survey. The company completed a move to a new office location during the year in which the study occurred; we included a dummy variable for the weeks in which the employee was packing, moving and unpacking as a control variable in analysis. We also control for the weeks during which the employee switched supervisors, or had their duties or task characteristics change significantly. We control for participants' gender and education.

Selection issues

The method of recruiting participants into the study was volunteering. This introduces a potential selection bias, such that volunteers and non-volunteers may differ systematically in ways that affect *the impact* of WWW on health and performance. For example, it is possible that those who volunteered to participate in the study are better able to work while walking than those

[12] Swimming is another form of energy expenditure, but it turns out that among the study participants there was only one person who reported in the baseline survey swimming for one hour in the prior week.
[13] Average of "Approximately how many hours did you exercise *to the point of perspiration* on Saturday?" Same question for Sunday.
[14] Average of "Approximately how many hours of television did you watch on Saturday? Sunday? Monday? Tuesday?"

who did not volunteer, so the effects we measure overstate the positive effects of the treadmills. The selection bias may also understate the effect of walking on performance or health; for example, individuals without health concerns may be more likely to enroll in the study, limiting their potential health improvements.

We examined whether our sample differs from the rest of the company's workforce though an analysis of determinants of participation in the study. We ran a logit regression with participation in the study as the dependent variable, and baseline (before the experiment began) independent variables: age, gender, education, Body Mass Index (BMI), marital status, work hours, hours of computer use, job task characteristics (routine, complexity, decision-making, teamwork), health perceptions and actions (diet, health behaviors, exercise), and time use (sports and exercise, active activities (like chores), and sedentary activities). We report the results in Appendix Table 1.

Employees who volunteered to participate in the study were different in some ways from other employees who did not volunteer but completed the baseline survey. Volunteers were more likely to perceive themselves as over 10 pounds overweight; however, their BMIs, calculated on the basis of their self-reported weight and height, did not differ significantly from other baseline survey respondents. They were more likely to be younger, more highly educated, and less likely to work in a team. In most other ways, however, the sample of volunteers looks similar to the other survey respondents in this company. We did not find any significant effect of hours of work, computer work, task characteristics, health behaviors or time use on the choice to participate. However, the fact that only about 10% of employees chose to volunteer suggests the possibility of unobserved factors that distinguishes between the two groups. To control for person-level unobserved characteristics, we conduct our analyses with difference in differences analysis and fixed effects regressions.

3. Results

We first establish in Table 3 that having a treadmill workstation is associated with increased physical activity. Next, we attempt to disentangle various unobservable factors that affect health and performance measures by looking at "difference-in-differences" - examining how changes in the treatment group's outcomes differ from the changes in the control group's outcomes. This analysis focuses on changes in outcomes between May and December 2008 when Walker 1 had treadmills (treatment group) and Walker 2 did not (control group), and the period January-May 2009, when both groups had treadmills. Since this is not a true double-blind study, we also examine differences for each group to glean changes in health and performance. Table 4 presents results for health measures and Table 5 for performance measures.

In order to examine the effect of WWW on weekly performance over time to detect learning and adjustment effects associated with the effective deployment of WWW by individual participants in the study, we use regression analysis (GLS), with employee fixed effects. We investigate the determinants of overall performance in Table 6 and of quality and quantity of performance and the quality of interaction with other employees in Table 7.

a. Results

Our first hypothesis concerns the effects of the availability of a treadmill in the office on physical activity. In Table 3 we present results of fixed-effects regressions on the number of minutes per day, averaged over a week, spent on sedentary, moderate and active physical activities. The three categories add up to 1,440 minutes (24 hours) per day but we present all three regressions for convenience of interpretation of the correlates of each type of activity. Model 1 captures the overall effect of having a treadmill in the office with a dummy variable; Model 2 adds the number of weeks with a treadmill, its squared and cubed values to capture its effect over time. The models also include a time trend (week and week squared) to capture any seasonal effects, and controls for illness and office moves. An observation is the number of minutes a study participant (Walker 1 and Walker 2) spent daily (averaged from weekly data) in each of the three types of activities.

- Insert Table 3 –

The results in Table 3 suggest that making a treadmill available in a study participant's office is associated with a reallocation of time across the three levels of activities, away from sedentary to moderate and active activities. The point estimate of having a treadmill in the office in Model 1 is about 20 fewer sedentary minutes a day. This number should be compared to the average daily sedentary time of approximately 1,000 minutes (Table 2), of which 500 may be accounted by sleep and another 50 minutes on commuting to work.[15] This leaves about 450 'discretionary' minutes for non-sedentary physical activity. Moderate and active activities increase by about 32 minutes per day on average. These effect sizes suggest that WWW contributes a small step towards the U.S. recommended 1,500 minutes per week, or about 215 minutes per day, of moderate activity.[16] Our results support Hypothesis 1.

The increase in time spent in active movement slightly declines over time and eventually stabilizes. Time spent in sedentary activity declines over the sample period.

We turn now to Hypothesis 2, which concerns the net effect of the introduction of WWW on health measures. Table 4 presents the difference-in-differences analysis, baseline values for the health measures for Walker 1 and Walker 2, and the changes in these measures during the first period, when only Walker 1 had treadmills, and during the second period, when both groups had treadmills. The first column (C1) in Table 4 reports the difference between the changes in health measures for Walker 1 (C4) and the changes in measures for Walker 2 (C7) during the period when only Walker 1 had treadmills. This is the treatment effect in the early experiment period. The second column is the difference-in differences for the entire study period (C5-C8), which includes the last 5 months when Walker 2 also had treadmills; this column reflects the treatment effect for the later experimental period.

Focusing on statistically significant differences, note that during the early period of the study, the change in the health of the treatment group (Walker 1) is better relative to the change health of the control group (Walker 2) with respect to percent body fat (-3.96) and TSH, thyroid stimulating hormone (-0.77). However, the systolic blood pressure for Walker 1 has worsened relative to Walker 2 during this period. (As columns C5 and C7 show, the difference in differences is the result of greater *reductions* in Walker 2 than in Walker 1 systolic blood pressure; why is that so is not clear). During the later period the net WWW effect there was a reversal in the WWW effect on body fat, but substantial gains in HDL (the cholesterol that rises with exercise and protects the heart), and further improvement in TSH (the hormone associated with metabolism). We also find reduction in the waist associated with WWW.

[15] These are approximate values derived from *America Time Use Survey 2009*, U.S. Bureau of Labor Statistics.
[16] WWW effects represent much more activity than that which was induced by interventions tried in other contexts. For example, an increase in usable sidewalks in a neighborhood increased active time by only 2.1 minutes per day, while inactive time fell 9.4 minutes (Jado, 2005).

- Insert Table 4 –

The effects of WWW in the first period are significant – statistically and substantively – for three measures, two of which are consistent with improved health. If the improvements were exhausted in the first period and the continued effect of WWW during the second period would be only that of maintenance of fitness then there should be no significant differences in column C2, so that the WWW effect in that period should be null. We find that there are improvements in two measures and deterioration in one measure. These findings offer mild support for the hypothesis that WWW improves significantly health. It takes perhaps greater use of the treadmills, or longer than one year, for the health effects to materialize.

The difference-in-differences analysis may be marred by the fact that although the volunteers were randomly assigned to Walker 1 and Walker 2, participants in Walker 2 knew that at the end of the period they will receive treadmills, which may have affected some of their behaviors and the effects of WWW even before they received treadmills.[17] Hence it is valuable to gain additional information by looking at changes in health measures over the entire study period for Walker 1 and Walker recorded in columns C5 and C8, respectively. Over the one year duration of the study 15 of the 18 changes are in the direction predicted by Hypothesis 2 (although most not reaching statistical significance). A cautious conclusion that can be drawn from the analysis in the right panel of Table 4 is that WWW is showing promise for health improvement.

To evaluate changes in employee performance over time and to test Hypothesis 3 we examine employees' weekly self ratings, as well as supervisor weekly rating of each of the approximately ten employees they oversee, pooling data for Walker 1, Walker 2 and Non-Walker.[18] Table 6 presents results for overall performance (on a scale of 1-10), and Table 7 for quality, quantity and interaction with others (on a scale of 1-5).[19] The explanatory variables

[17] Criticism of difference-in-differences analysis is provided by Bertrand, Duflo and Mullainathn (2006).

[18] There are more than 7,000 employee weekly observations from employee reports but less than 4,000 observations from supervisors. The discrepancy arises from the fact that the response rate of supervisors is lower than that of employees, and because we included supervisor reports only for weeks when their employees also completed the weekly survey (we did not eliminate observations for employees for weeks that their supervisors did not complete their surveys).

[19] The weekly survey question on overall performance refers to the previous week, whereas the questions about quality, quantity and interaction with coworkers refer to Monday and Tuesday prior to the weekly survey, which was

include a dummy variable representing the availability of a treadmill (0 for all non-walkers' observations) and the number of weeks with a treadmill in the office in quadratic form to capture the full effect of the availability of a treadmill overtime (Ployhart and Vandenberg, 2010). We also include a time trend and its square to capture seasonal and other common effects, as well as controls for changes in the workplace (moving office) and illness-related absences that may affect performance. We also include in Model 2 of Table 6 and in Table 7 variables that represent active and sedentary activities outside the workplace – exercise on the weekend and TV viewing on the weekend and the two days preceding the weekly survey, and which may affect work performance. These variables are possibly affected by WWW for reasons outlined in Section 1.

In Table 6, having a treadmill in one's office is associated with an increase in self-rated overall performance of about 0.4 point. This statistically significant improvement is averaged over the entire period. As hypothesized, performance declines initially but starts rising again. For the average study participant, self-rated performance initially declines but starts rising again about half a year (27 weeks in Model 1 and 28 weeks in Model 2) after the introduction of WWW, exceeding the initial level one year of using WWW.

Exercise on the weekend is associated with improved performance (Model 2); an additional exercise session is associated with a 0.04 increase in self-rated performance, a very small effect. As noted, this is a behavior that may be itself affected by WWW. TV viewing has no significant relationship to performance.

- Insert Table 6 -

The estimates for supervisor-rated performance are not significant. The reason for that, in addition to the fact that there are fewer observations in the supervisor-rated regressions, may be the inability of supervisors to notice small changes over short periods of time. Each supervisor has about 10 supervisees, and therefore supervisor ratings may be less sensitive to small changes such as those associated with WWW. Supervisors may be more attuned to discrete factors such

administered on Wednesday. If the employee was absent (for any reason) on one of the two days the observation was recorded as missing. As a result, we have more observations for Table 6 and for Table 7.

as absences, which affect negatively assessment of overall employee performance (but less strongly than by employees themselves).[20]

Table 7 presents an analysis of the three sub-dimensions of performance: the quality and quantity of work and the quality of interaction with coworkers (each assessed on a scale of 1-5). We present here only estimates for Model 2; Model 1 estimates are quite similar. The learning pattern that we observed for overall self-rated performance as well as the overall positive effect of the treadmill workstation reported in Table 6 is replicated here, for employee self-ratings. Concerning the quality, quantity and interaction with others (self-rated performance) there is an initial decline, followed by a turnaround after 22, 24 and 28 weeks, respectively, consistent with the values reported for overall performance.

Weekend exercise and TV viewing are not significantly associated with the sub-dimensions of performance. As in Table 6, absence during the previous week is associated with lower self-reported performance.

- Insert Table 7 -

Employee-rated performance variables follow the pattern postulated in Hypothesis 3. In addition, all of our employee-rated regressions suggest an overall positive impact of the treadmill workstations on performance. Hypothesis 3 is not supported by supervisor performance ratings, but as noted these ratings are likely to be relatively insensitive to actual changes.

b. Discussion

The results presented above suggest that there are small effects in the three areas investigated here. The results generally support the hypotheses we postulated. One important finding that emerges from all analyses is that there is a process of adjustment and learning that unfolds over a period of months, and probably years. Our year-long study captured some of these effects; a longer study period may be able to detected additional patterns. The health effects that we found identify small changes, mostly but uniformly in desirable directions. The health system

[20] Researchers find low correlation between self and supervisory ratings; in a meta-analysis, Harris and Schaubroek (1988) find a correlation of .35. This correlation must be lower for short observation periods, during which a supervisor may have little or no interaction with each of his or her supervisees. Self-reports may be inflated, but weekly changes cannot be systematically be biased upward.

is a complex one, where physical activity at different levels has varying effects, depending at the fashion in which they are interspersed, how nutrition is affected by physical activity, how the body adjusts to changes, and much more. These multiple changes are difficult to model and to capture quantitatively in a relatively small sample.

The performance effects, which we measured weekly, are convex in time. The introduction of a drastically new work technique, walking on a treadmill while working, requires much adjustment and learning on the part of employees who have been accustomed to a sedentary execution of their work duties. The ability of our study participants to recover their initial productivity in its various facets suggests that WWW can be made to work successfully. Employees adjusted to their new work environment without the benefit of others' experience; they each had to learn how to cope and adjust individually. It is important to note that although pre-WWW productivity was regained after one year, that period represents a loss of productivity.

It is reasonable to expect that the various health and performance effects are not uniform across all employees and all participants in the study. One may conjecture that initial the health condition of participants predisposes them to different gains. For example, an individual who exercises regularly and vigorously can expect to gain little from walking at work. In contrast, a thoroughly sedentary and overweight individual may take a long time to enjoy the gains of physical activity, and on the short run may even suffer from symptoms of an unhealthy change due to elevated blood pressure that stays such for hours after minimal exertion. The short term gains may accrue most clearly to people in the middle range between the two extremes exemplified above.

Similarly, the performance effects of WWW may be contingent on these factors as well as on specific job characteristics. A nimble, healthy and fit employee may find the transition from sitting to standing and walking easy to accomplish and may improve his or her performance relatively quickly. In contrast, an employee who has physical or psychological discomfort associated with change may experience a decline in productivity that takes a long time to recover, or even a long term decline because of the difficulty of making adjustments from sitting to standing to walking at different speeds in the course of the day. The characteristics of an employee's tasks constitute another contingency that may affect performance in relatively obvious ways. Those whose tasks involve a lot keyboarding will gain less (or perhaps lose productivity if they cannot adjust as needed) than those whose tasks involve complex problem solving.

Our small sample size does not permit a careful analysis of the various contingencies that may affect the impact of WWW on health and performance. We conducted a series of analyses to evaluate the role of health and job characteristics that existed before the introduction of WWW and the effects of WWW. The moderating effect of the key variables (pre-WWW exercise, BMI, quarterly performance evaluation, job complexity and interdependence with other employees) on changes in outcomes is approximately nil. Although we find a strong positive correlation between BMI and quarterly performance, this effect vanishes on a longer time frame. This is an important area of investigation and research is clearly required in order to understand better who benefits more from WWW.

5. Conclusions

In this study, we test a novel workplace fitness intervention that allows individuals to walk while they are working at a mild to moderate intensity (2 mph or lower). We find that the addition of treadmills to ordinary offices and cubicles for workers in sedentary jobs reduces the time spent on sedentary activities and increases slightly the amount of time they are active, net of any habit-forming or substitution effects. We find that the introduction of treadmill workstations has a very small, but significant, effect on some aspects of health (TSH, waist circumference, and HDL cholesterol levels), while body fat percentage initially falls and subsequently returns to initial levels. Overall job performance initially falls slightly, as walkers learn to deal with the cognitive constraints of focusing attention on both work tasks and walking. Subsequently, self-rated job performance improves with walking. These trends are mimicked in the performance sub-dimensions of quantity and quality. Supervisor-rated performance does not appear to be related to walking-while-working.

While physical activity improves health, its impact on job performance is more difficult to ascertain, although we do find some evidence that is supportive of a positive relationship. In addition to the overall small positive effect of the presence of the treadmill in one's office on self-rated performance (which is assumed to occur because the employee uses his or her treadmill), employees also report higher performance during the weeks followed by more intense exercise (to the point of perspiration) on the weekends. Self-reported sedentary activity, consisting of watching television and movies, is not related to any dimension of job performance.

The introduction of treadmills in the workplace is obviously not a silver bullet for health or performance. Should companies introduce treadmills in offices? The gain in health may produce cost savings in the short and long runs, and the eventual gain in productivity after the first year should be compared with the initial and ongoing costs of the treadmill and the first year productivity loss. The gains can be enhanced and the losses mitigated by careful attention to the introduction of treadmills with appropriate guidance to employees as well as to possibly greater encouragement to individuals who can most benefit from using treadmills. More research on each of the elements discussed in this paragraph is required before moving to large-scale implementation of treadmills in the workplace.

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Treadmill workstation

Accelerometer

Table 1. Key Variables and Data Sources

Class of Variables	Frequency	Source	Group for which variables are available
Employee health	Quarterly	Biometric medical testing	Walker 1 Walker 2
Daily energy expenditure	Continuous	Energy expenditure measuring equipment (accelerometer)	Walker 1 Walker 2
Employee performance	Weekly and quarterly	Weekly and quarterly - employee surveys - supervisor surveys	Walker 1 Walker 2 Non-walker
Employee non-work physical activities	Weekly and quarterly	Weekly and quarterly employee surveys	Walker 1 Walker 2 Non-walker

Table 2. Definition of Variables, Sources and Descriptive Statistics

Variable	Definition	Source	Grand Mean Across Time (s.d.)		
			Walker 1	***Walker 2***	***Non-Walker***
Health Measures					
Weight	Employee's weight in kilograms	Biometric Data	90.27 (37.18)	82.62 (18.68)	N/A
%Fat	Percentage of body fat	Biometric Data	31.33 (8.16)	30.81 (8.30)	N/A
Triglycerides	Measure of Triglycerides	Biometric Data	128.06 (63.66)	123.43 (68.67)	N/A
HDL	HDL Cholesterol	Biometric Data	57.57(22.31)	56.53 (19.35)	N/A
LDL	LDL cholesterol	Biometric Data	105.29 (22.80)	114.49 (27.85)	N/A
TSH	Thyroid Stimulating Hormone	Biometric Data	2.28 (1.01)	2.08 (1.11)	N/A
Waist	Waist Circumference in inches	Biometric Data	37.99 (9.64)	35.36 (5.34)	N/A
Systolic BP	Systolic Blood Pressure	Biometric Data	131.93 (11.60)	127.99 (11.70)	N/A
Diastolic BP	Diastolic Blood Pressure	Biometric Data	84.24 (9.36)	85.99 (7.87)	N/A
Initial body mass index (BMI)	$\text{Weight(kg)}/(\text{height(m)})^2$	Employee Baseline Survey	29.66 (8.98)	26.66 (4.00)	29.73 (7.52)
Employee Performance Measures – Self reports					
Overall performance	Past quarter's overall performance	Weekly & Quarterly Survey	8.13 (0.99)	7.71 (1.15)	8.09 (1.31)
Performance Quantity	Past week's quantity of work done	Weekly Survey	3.41 (0.64)	3.35 (0.65)	3.50 (0.65)
Performance Quality	Past week's quality of work done	Weekly Survey	3.48 (0.61)	3.41 (0.67)	3.60 (0.60)
Interaction Quality	Past week's quality of interaction with coworkers	Weekly Survey	3.51 (0.63)	3.35 (0.64)	3.39 (0.65)
Employee Performance Measures – Supervisor reports					
Overall performance	Past quarter's overall performance	Weekly & Quarterly Survey	7.79 (1.28)	8.60 (1.08)	8.21 (1.52)
Performance Quantity	Past week's quantity of work done	Weekly Survey	3.25 (0.62)	3.58 (0.62)	3.56 (0.74)
Performance Quality	Past week's quality of work done	Weekly Survey	3.37 (0.59)	3.58 (0.58)	3.63 (0.70)
Interaction Quality	Past week's quality of interaction with coworkers	Weekly Survey	3.40 (0.60)	3.44 (0.57)	3.49 (0.67)

Physical Activity Measures					
Active calories	Calories spent moving at a rate equivalent to walking 2 mph or more	Biometric data (accelerator)	378 (418)	178 (212)	N/A
Moderate calories	Calories spent moving at a rate equivalent to walking <2 mph but more than 1mph	Biometric data (accelerator)	716.6 (378.5)	671 (328)	N/A
Sedentary calories	Calories spent moving <1 mph	Biometric data (accelerator)	193 (144)	132 (86)	N/A
Weekend Exercise	Number of times exercising to the point of perspiration	Employee Weekly Survey	0.85 (1.00)	0.59 (0.79)	0.66 (0.90)
Initial Weekly Exercise	Weekly exercise time (minutes)	Employee Baseline Survey	17.10 (19.63)	18.01 (17.20)	5.96 (8.07)
Television Viewing	Average daily hours of TV viewing in the four days prior to the survey	Employee Weekly Survey	0.81 (0.73)	1.06 (0.90)	1.55 (1.09)
Days absent due to illness	Days absent from work due to own illness during the past week	Employee Weekly Survey	0.06 (0.32)	0.06 (0.40)	0.09 (0.37)
Task and Work Environment Measures					
Task complexity	Extent to which job tasks are complex (1-5)	Supervisor Quarterly Survey	3.47 (0.82)	3.31 (0.86)	3.19 (0.97)
Task routine	Extent to which job tasks are routine (1-5)	Supervisor Quarterly Survey	3.15 (0.69)	3.12 (0.72)	3.25 (0.93)
Computer hours	Hours per day working directly on the computer	Employee Quarterly Survey	6.05 (1.42)	6.27 (1.86)	6.61 (2.08)
Moved office location	Packed or moved to a new location during this week = 1	Archival data	0.03	0.03	0.03
Duty changed	Switched supervisors or duties changed significantly = 1	Employee Weekly Survey	0.08	0.04	0.04
Employee Characteristics					
Female	Gender dummy variable (female = 1)	Employee Quarterly Survey	0.76	0.80	0.80
Education	College educated dummy (BA/ MA = 1)	Baseline Survey	0.51	0.47	0.33

Table 3. The Relationship between Having a Treadmill in Office and Time Spent in Sedentary, Moderate and Active Activities (Fixed Effects) Walker 1 and Walker 2 Sample

	Sedentary (<1 mph)		Moderate (1-2 mph)		Active (>2 mph)	
	Model 1	*Model 2*	*Model 1*	*Model 2*	*Model 1*	*Model 2*
Had treadmill during the current week	-20.154*	-19.822*	14.744*	13.625	17.841***	11.386***
	[10.320]	[11.430]	[8.516]	[9.489]	[3.826]	[4.205]
Number of weeks with treadmill		3.372***		-1.588		-0.312
		[1.245]		[1.031]		[0.465]
(Number of weeks with treadmill)^2*10^3		-0.033		0.012		-0.019*
		[0.026]		[0.022]		[0.010]
Absence due to illness	8.504	8.277	-3.182	-3.098	-9.084***	-9.275***
	[8.777]	[8.742]	[7.224]	[7.219]	[3.213]	[3.181]
Moved office locations	37.296**	40.223**	-35.401**	-36.923**	-1.586	-2.76
	[18.114]	[18.052]	[14.899]	[14.897]	[6.787]	[6.724]
Constant	1122.964***	1125.728***	272.480***	271.120***	43.418***	43.091***
	[10.225]	[10.262]	[8.475]	[8.540]	[3.911]	[3.906]
N	1180	1180	1176	1176	1126	1126
R^2 (within)	0.106	0.116	0.105	0.109	0.112	0.133
F	26.99	21.21	26.71	19.75	27.38	23.62
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000

Notes:
All estimations include a time trend and its square.
Standard errors in parentheses. *, ** and *** refer to statistical significance at the 0.01, 0.05 and 0.1 levels.

Table 4. WWW and Health: Differences-in-Differences Analysis

	Difference-in-Differences		**Walker 1**			**Walker 2**		
	Net first period effect C4-C7 C1	***Net second period effect C5-C8 C2***	***Baseline C3***	***Δ(May 08-Dec 08) C4***	***Δ(May 08 – May 09) C5***	***Baseline C6***	***Δ(May 08-Dec 08) C7***	***Δ(May 08 – May 09) C8***
Weight	1.22	0.36	90.91	-0.39	-0.97	83.46	-1.61	-1.33
	(0.25)	(1.00)	(35.60)	(0.50)	(0.92)	(19.42)	(0.55)	(0.74)
% Fat	-3.96***	2.53**	31.18	-1.83	1.17	30.53	2.13	-1.36
	(0.00)	(0.06)	(8.11)	(0.68)	(0.61)	(8.63)	(0.56)	(0.89)
Triglycerides	20.74	-1.79	132.62	4.31	-13.92	132.57	-16.43	-12.14
	(0.70)	(0.48)	(64.91)	(19.19)	(12.16)	(97.95)	(10.80)	(15.26)
HDL	1.21	7.24***	53.85	0.38	8.85	56.26	-0.83	1.61
	(0.41)	(0.00)	(22.52)	(1.89)	(2.76)	(19.34)	(1.37)	(1.21)
LDL	-7.32	5.59	107.38	-6.54	-1.54	116.61	0.78	-7.13
	(0.66)	(0.66)	(31.54)	(5.92)	(5.92)	(30.68)	(5.54)	(5.54)
TSH	-0.77**	-0.86***	2.63	-0.76	-0.46	1.96	0.01	0.40
	(0.02)	(0.01)	(1.39)	(0.29)	(0.18)	(1.03)	(0.17)	(0.18)
Waist	-0.28	-0.65*	39.11	-1.43	-1.93	36.17	-1.15	-1.28
	(0.54)	(0.09)	(9.73)	(0.38)	(0.30)	(5.68)	(0.27)	(0.34)
Systolic BP	11.13***	3.32	131.21	3.00	-0.86	132.09	-8.13	-4.17
	(0.00)	(0.46)	(11.65)	(2.76)	(2.33)	(14.05)	(1.94)	(1.67)
Diastolic BP	8.57	7.59	84.21	-0.21	0.29	91.35	-8.78	-7.30
	(0.89)	(0.55)	(10.88)	(1.94)	(2.95)	(20.66)	(4.44)	(4.60)

Notes:
- ***Net first period effect =*** ΔW1-ΔW2 May-Dec 08 = (Change in Walker 1 measures) – (Change in Walker 2 measures) for the period May/June 2008 (average of 6 weeks) to December 2008 (average of 4 weeks). This is the net (clean) first period effect of WWW.
- ***Net second period effect =*** ΔW1-ΔW2 May 08-May 09 = (Change in Walker 1 measures) – (Change in Walker 2 measures) for the period May/June 2008 (average of 6 weeks) to May 2009 (average of 4 weeks). This is the net (clean) second period effect of WWW.
- Probability of the Mann-Whitney 'U' statistic in parentheses in columns C1-C2. *, ** and *** refer to statistical significance at the 0.01, 0.05 and 0.1 levels.
- Standard errors in parentheses in columns C3-C7.

Table 6: Determinants of Overall Weekly Performance – Walker 1, Walker 2 and Non-Walker Pooled (Fixed Effects GLS)

	Employee-Rated Performance		Supervisor-Rated Performance	
	Model 1	**Model 2**	**Model 1**	**Model 2**
Had treadmill during the current week	0.378***	0.409***	0.044	-0.022
	(0.077)	(0.077)	(0.180)	(0.191)
Number of weeks with treadmill	-0.038***	-0.040***	-0.003	-0.003
	(0.008)	(0.008)	(0.010)	(0.011)
(Number of weeks with treadmill)^2*10^3	0.695***	0.702***	-0.082	0.302
	(0.182)	(0.188)	(0.323)	(0.252)
Moved office locations	-0.001	0.007	0.037	0.032
	(0.061)	(0.061)	(0.047)	(0.070)
Absence due to illness	-0.383***	-0.398***	-0.150***	-0.149***
	(0.029)	(0.030)	(0.052)	(0.040)
Exercise on the weekend		0.042***		-0.022
		(0.016)		(0.018)
Television viewing in past four days		0.001		-0.004
		(0.017)		(0.020)
Constant	7.885***	7.755***	7.307***	7.327***
	(0.030)	(0.042)	(0.038)	(0.049)
N	7577	7013	3873	3855
R^2	0.027	0.035	0.028	0.027
F	31.80	24.77	12.60	10.22
Prob > F	0.000	0.000	0.000	0.000

Notes:
All estimations include a time trend and its square.
Standard errors in parentheses. *, ** and *** refer to statistical significance at the 0.01, 0.05 and 0.1 levels.

Table 7. Determinants of Different Dimensions of Weekly Performance – Walker 1, Walker 2 and Non-Walker Pooled (Fixed Effects GLS)

	Employee Rated Performance			***Supervisor Rated Performance***		
	Quality	**Quantity**	**Interaction**	**Quality**	**Quantity**	**Interaction**
Had treadmill during the current week	0.151***	0.151***	0.163***	0.046	0.013	0.013
	(0.044)	(0.044)	(0.044)	(0.089)	(0.056)	(0.099)
Number of weeks with treadmill	-0.016***	-0.016***	-0.015***	-0.007	-0.002	0.002
	(0.004)	(0.005)	(0.005)	(0.219)	(0.010)	(0.006)
(Number of weeks with treadmill)^2*10^3	0.365***	0.338***	0.267**	-0.022	-0.071	-0.111
	(0.105)	(0.106)	(0.106)	(0.142)	(0.230)	(0.140)
Absence	-0.083***	-0.060***	-0.061***	-0.017	-0.041	-0.058**
due to illness	(0.017)	(0.020)	(0.017)	(0.024)	(0.020)	(0.024)
Moved office	-0.0204	-0.029	0.001	0.023	-0.029	-0.029
Location	(0.035)	(0.038)	(0.033)	(0.035)	(0.048)	(0.039)
Weekend exercise	0.026	0.002	-0.011	-0.010	-0.014	-0.013
	(0.009)	(0.010)	(0.009)	(0.009)	(0.016)	(0.010)
Television viewing	0.011	0.001	-0.006	0.009	-0.004	-0.025**
	(0.010)	(0.011)	(0.010)	(0.013)	(0.016)	(0.012)
Constant	3.69***	3.53***	3.55***	3.60***	3.57***	3.53***
	(0.024)	(0.027)	(0.024)	(0.042)	(0.030)	(0.028)
N	6751	6751	6083	3651	3651	3651
R^2 (within)	0.015	0.012	0.005	0.009	0.011	0.006
F	8.67	7.03	3.62	3.04	4.04	3.19
Prob > F	0.000	0.000	0.000	0.012	0.000	0.000

Notes:

All estimations include a time trend and its square.

Standard errors in parentheses. *, ** and *** refer to statistical significance at the 0.01, 0.05 and 0.1 levels.

Appendix Table 1: Selection Effects: Correlates of participation in the study (logit, clustered by supervisor, robust standard errors)

	Coefficient	Standard Error
Female	0.293	0.654
Age < 30	14.44***	0.830
Age 31-40	14.04***	0.887
Age 41-50	13.83***	1.05
Age 51-60	12.43***	1.32
Associates degree (AA/AS)	0.975	0.902
Bachelor's degree (BA/BS)	-0.697	0.615
Master's degree (MA/MS/MBA)	1.44**	0.593
BMI	-0.076	0.062
Exercise to perspiration (times/week)	0.142	0.170
Weekly exercise hours	-0.004	0.021
Activities requiring movement	-0.015	0.012
Movie and television time	0.007	0.017
Smoke	-0.443*	0.251
Ten or more pounds overweight	0.550**	0.275
Try to eat balanced diet	0.173	0.420
Married/living with partner	-0.106	0.589
Kids	0.264	0.298
Employee-rated performance	-0.164	0.237
Supervisor-rated performance	0.092	0.236
Supervisory status	0.780	0.771
Complex tasks (SUP)	-0.150	0.559
Routine tasks (SUP)	-0.045	0.345
Decision making responsibility (sup)	-0.343	0.802
Extent of teamwork (SUP)	-0.811**	0.345
work group size	0.049	0.162
Computer hours	-0.067	-0.201
Total hours at work	0.046	0.465
Constant	-11.95***	3.246
N	155	
pseudo R^2	0.233	
Chi^2	1586	
P value	0	

Notes:
All variables from the employee baseline survey except those marked SUP, which are from the supervisor baseline survey.
Supervisory status and work group size are from archival data. *, ** and *** refer to statistical significance at the 0.01, 0.05 and 0.1 levels.

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12/07	*The Effects of Walking while Working on Productivity and Health: A Field Experiment.*
	Avner Ben-Ner, Darla Flint Paulson, Gabriel Koepp, James Levine