

PERKINS+WILL Research Journal +7 2017 / VOL 09.02

O1. ACTIVATING THE WORKPLACE:

The Impact of Active Workstations on Employee Effectiveness Mary Baker, mary.baker@perkinswill.com

ABSTRACT

Today's workforce understands that sitting all day is not healthy. As a result, employees are increasingly requesting more opportunities for movement throughout the workday. Workplace design has evolved to address sedentary behavior through active workstations, which allow individuals to experience the benefits of movement and posture change while engaging in productive work.

Research on the health impacts of active workstations is well established, and most studies show an inverse relationship between the availability of active workstations and workers' sedentary behavior. However, evidence of how these interventions impact employees beyond reducing sedentary behavior is still emerging. This paper contributes to this developing body of research by providing an overview of how active workstations affect an individual's ability to effectively perform everyday job responsibilities. For the purposes of this paper, active workstations are defined as height-adjustable and treadmill desks.

To explore the relationship between active workstations and employee effectiveness, a literature search was conducted. Articles were reviewed if they were published in a peer-reviewed journal within the past 10 years, analyzed more than just sedentary behavior, and were generalizable to the workplace.

Findings suggest that height-adjustable desks have a neutral or positive impact on cognitive function and productivity/performance, and a positive impact on psychological outcomes, such as mood or energy levels. Research on the relationship between treadmill desks and employee effectiveness is still emerging, but preliminary evidence suggests that treadmill desks have a neutral or positive effect on cognitive function and psychological outcomes like boredom and satisfaction, and a mixed impact on productivity/performance. More robust, long-term studies are necessary to determine the impact that active workstations have on employee effectiveness over time.

KEYWORDS: active workstation; workplace; cognitive function; productivity; well-being

1.0 INTRODUCTION

You may want to stand up for this: Research shows that sedentary behavior causes or intensifies a wide range of health problems^{1, 2, 3}. Contrary to popular belief, physical inactivity and sedentary behavior are two distinct behaviors. A mounting body of evidence suggests total sedentary time is negatively associated with health risks like heart disease, diabetes, musculoskeletal pain, and

abdominal obesity independent of "protective contributions of moderate-to-vigorous physical activity"⁴. To put it bluntly, no matter how much you exercise, if you spend the majority of your day sitting, you may be prone to serious health risks.

A 2013 study reported that sedentary time accounts for 82 percent of employees' work hours⁵. Several studies

have validated that office workers spend the majority of their workday sitting down^{6, 7, 8}, and estimates of cumulative daily sedentary time (including sleep) reach 11 to 16 hours a day^{9, 10, 11}. Because sedentary behavior is so prevalent during work hours, health professionals have pinpointed the workplace as a prime location to reduce sitting. Organizational leaders have taken note, and many companies now provide employees with active workstations to encourage more standing and movement in the workplace.

In response to active workstations' growing popularity, researchers have designed experiments to verify whether or not the interventions are successful in decreasing workplace sedentary behavior. These experiments also frequently evaluate health measures like caloric expenditure, blood pressure, and heart rate, among others. Perhaps unsurprisingly, the adoption of active workstations has been linked to decreased time spent sitting at work, and has also had demonstrated effects on employees' health and well-being.

However, evidence on how active workstations impact employees beyond sedentary behavior is still emerging. Many employers, while intrigued by the established health benefits of active workstations, wonder if these non-traditional interventions might impede workers from completing normal work tasks.

To help answer this question, this article reviews an emerging body of research that asks how active workstations affect an individual's ability to effectively perform his/her everyday job responsibilities. The active workstations considered in this article are height-adjustable and treadmill desks, since they are the most common active workstations on the market today. Specifically, this article explores the relationship between active workstations and employee effectiveness through three main areas: cognitive function, productivity/performance, and psychological outcomes. Preliminary evidence on the relationship between these employee effectiveness areas and active workstations, along with their proven impact on workplace sedentary behavior, make a compelling case for the active workstation as a tool to promote workplace well-being.

1.1 Methodology

The author conducted a literature review of articles published from January 2007 to May 17, 2017. An article was included in this review if it met the following criteria: (1) published in a peer-reviewed journal within the past 10 years, (2) analyzed more than just sedentary behavior and or physical health, and (3) was generalizable to the workplace. Ultimately, 16 articles met this inclusion criteria, with approximately 70 percent of considered papers excluded. The main reasons for exclusion included: a lack of consideration of employee effectiveness measures (the study solely measured sedentary behavior or physical health), and a lack of generalizability to the workplace (the study took place in an elementary school classroom). All graduate student dissertations and theses were excluded unless they were published in a peer-reviewed journal.

1.2 Definitions

Three main concepts related to employee effectiveness were researched for this review. The following definitions are adopted from articles that explore these topics.

Cognitive function: A set of mental processes responsible for perception, memory, learning, and action, involving skills such as planning, problem solving, task switching, decision-making, and critical thinking¹².

Productivity/performance: Across the studies, productivity/performance are generally measured by how efficiently and accurately an individual performs the tasks that constitute his/her job responsibilities^{13, 14, 15}.

Psychological outcomes: Psychological states and feelings, measured by variables such as:

Arousal: Feelings of activation and reactivity, associated with productive coping responses

Boredom: A state of being restless through lack of interest, often associated with distraction from work

Stress: Negative cognitive outcomes associated with completing a task, often causing mental or bodily tension

Task satisfaction: Refers to a pleasurable or positive emotional state resulting from completing a $task^{16}$.

2.0 ACTIVE WORKSTATIONS—WORKPLACE TREND OR THE NEW NORMAL?

Attention-grabbing headlines like "Sitting is the New Smoking"¹⁷ have made the health risks of excessive sedentary behavior well known among the general public. Similarly, health benefits of active workstations are growing more apparent, due to favorable popular

press^{18, 19, 20} and even celebrity endorsements from the likes of late-night television host Jimmy Kimmel and fashion designer Victoria Beckham, who are both avid treadmill desk users^{21, 22}.

This widespread media coverage relates to a growing interest in workplace health and wellness. A recent report dubbed wellness "the next trillion-dollar industry," indicating that "the trends all point in a single direction—more and more consumer spending on health and wellness...as employers invest in healthy living programs and as customers take more responsibility for optimizing their own health"²³. And if the rise of wellness certifications, such as Fitwel or WELL, are any indication, health and well-being in the workplace are taken seriously by employers and designers alike.

Active workstations—especially height-adjustable desks—are becoming more commonplace across different industries, playing a key role in workplace reengineering for health and well-being. According to the Perkins+Will benchmarking database, 60 percent of our benchmarked projects offer height-adjustable desks for employees²⁴. While the database does not quantify

treadmill desk implementation, Perkins+Will designers have observed clients' growing interest in treadmill desk programs. For example, one consumer products company implemented a "walkstation" treadmill desk program, which offered the desks in both open and private areas within their office. Another client took treadmill desks a step further by including a treadmill conference table, facilitating simultaneous walking, computer work, and collaboration. Design experts forecast that the ubiquity of active workstations will only continue to grow, especially as a healthy workplace is solidified as a competitive advantage for companies attempting to attract and retain talent²⁵.

2.1 A Brief Summary of the Known Health Impacts of Active Workstations

Although this article focuses on how active workstations impact employee well-being beyond physical health, background information on the health impacts of height-adjustable and treadmill desks will help establish how active workstations support workers' ability to succeed on the job.



Figure 1: "Height-adjustable desks, or sit-stand desks" allow workers to easily move their work surface up or down to facilitate standing throughout the day.

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Height-adjustable desks (commonly called "sit-stand desks") allow workers to easily move their work surface up or down to facilitate periods of standing and posture change throughout the day, as seen in Figure 1. As workers change posture, large muscle groups in the legs and trunk are exerted, pumping blood throughout the musculoskeletal system²⁶. Overall, compared with sitting all day, using height-adjustable desks promotes:

higher caloric expenditure²⁷, reduced risk of type 2 diabetes²⁸, and reduced risk of cancer²⁹. However, researchers caution that impactful sit-stand desk usage is dependent "on the culture instituted in the workplace" and that "workers must be diligent about changing heights throughout the day over the long term"³⁰ in order to enjoy significant health benefits.



Figure 2: Treadmill desks allow employees to walk at a slow pace while performing normal job responsibilities.

Treadmill desks allow employees to walk at a slow pace while performing normal job responsibilities, as seen in Figure 2. According to numerous studies, the availability of treadmill desks at work results in significant reductions in workplace sedentary behavior, 31, 32, 33, 34 with one study reporting that participants reduced time spent sitting by 66 minutes per day, which represents a 224 percent decrease³⁵. Compared to height-adjustable desks, treadmill desks allow for an even higher caloric expenditure³⁶ and greater physiological improvements like "sustained reductions in blood pressure"³⁷. They have also been associated with moderate decreases in body weight and weight circumference^{38, 39, 40}. Most researchers agree, however, that the primary benefit of treadmill desks is reduced sedentary behavior, acknowledging that modest weight loss is associated with long-term usage and mainly occurs in obese participants. In short, treadmill desks should not be deemed a substitute for vigorous physical activity, but should be seen as a valuable tool to help increase movement throughout the day.

The introduction of height-adjustable and treadmill desks into the workplace can be an effective strategy to combat workplace sedentary behavior. These interventions also have demonstrated effects on key health outcomes, especially when used over the long term.

3.0 ACTIVE WORKSTATIONS—BEYOND PHYSICAL HEALTH

Decision-makers at companies often understand the importance of decreasing sedentary behavior at work, but want more than just health information when deciding whether or not active workstations are a good fit for their workplaces. An emerging body of research responds to this concern by focusing on the impact of active workstations on how employees think, perform, and feel. The following sections review evidence on how height-adjustable and treadmill desks influence employees' cognitive function, productivity/performance, and psychological outcomes.

3.1 Cognitive Function

Cognitive function, or cognition, refers to a set of mental processes responsible for perception, memory, learning, and action, and involves skills such as planning, problem solving, task switching, decision-making, and critical thinking⁴¹. The cognitive process is constantly present in our everyday lives, whether we are aware of it (such as when we complete a complex math problem), or not (when we automatically stop our vehicles when

we see a red light). Studies on cognition are especially relevant to the workplace, because cognitive abilities like communication, thinking, and learning form the foundation of all workplace activities—from the simple to the complex. This section asks whether or not active workstation use promotes or impedes cognition in the workplace.

Height-Adjustable Desks

Current research on the relationship between heightadjustable desks and cognitive function is underdeveloped. Most researchers design their experiments on active workstations and cognition to study the impact of movement. Because of this, it is possible that heightadjustable desk usage may not be considered relevant for this research focus, since the intervention promotes posture change and standing, but not continuous movement. Nonetheless, the relationship between cognition and height-adjustable desks is addressed in two recent studies. Findings from these studies suggest that height-adjustable desks have a positive or neutral effect on cognition.

A 2016 comparison study on cognitive effects following periods of standing and walking at active workstations reported promising findings. Significant performance improvements were found in both the standing and walking conditions for psychomotor function and working memory and attention, suggesting that posture change may be as effective as walking for these cognitive effects⁴². However, executive function performance, or reasoning and problem solving, remained neutral in both conditions. Researchers reason that "chronic exposure to standing may be required to elicit improvements," citing a longer-term study of height-adjustable desks in schools which reported improvements in executive function⁴³. This study suggests that the performance effects of active workstation use may vary by area of cognition, but notably did not find significant decreases in cognition in the standing or walking conditions.

Furthermore, a 2011 study on attention and memory while sitting, standing, or using a treadmill workstation also reported favorable findings⁴⁴. While researchers did not observe significant improvements in attention or memory while standing or walking, they also did not report significant detriments to these aspects of cognition. Therefore, the authors of this study support the use of active workstations while performing activities that require memory and attention, since cognitive performance remains neutral, yet the benefits of decreased sedentary behavior can be achieved.

Treadmill Desks

Compared to height-adjustable desks, research on the relationship between cognition and treadmill desks in the workplace is more fully developed. It is possible that there is a greater interest in this relationship due to the precedent set by neuroscientists and health scientists, who frequently study cognition and movement together when exploring how exercise may benefit memory and intelligence. Additionally, organizational stakeholders often express concerns over the "dual demands" of mental processing and walking that treadmill desk usage requires⁴⁵. In response, researchers have employed a variety of cognitive battery tests in lab settings to explore how walking at a treadmill desk impacts cognition at work.

Overall, study results suggest that treadmill desks have a neutral or positive impact on cognitive function^{46, 47,} ^{48, 49, 50}. For example, a 2014 study found no significant differences in response speed or accuracy for any of the cognitive tests performed between the walking and seated conditions⁵¹. Similarly, a study on memory did not find any significant impairments in cognition between the seated and walking conditions, indicating that "subjects performed the spatial working memory task equally well at all walking speeds"⁵².

Notably, although both of these studies have similar outcomes, their designs were dissimilar with regard to walking speed. The first study allowed participants to select their walking speed, while the second study required participants to walk at a range of speeds determined by the researchers during the experiment. However, participants performed equally well on their tasks across all walking speeds, suggesting that walking speed does not affect cognitive performance, and that the population examined has the ability to allocate sufficient resources to cognition regardless of walking speed⁵³. Although generalizability to the workplace has not yet been established, initial results on the relationship between cognition and treadmill workstation use are promising.

3.2 Productivity/Performance

Employees' productivity/performance play an essential role in the financial and operational success of organizations. Although these parameters are defined differently across companies, their core meaning relates to how efficiently and accurately an individual performs the tasks that constitute his/her job responsibilities. The Harvard Business Review summarizes the importance of productivity succinctly:

"The ultimate...goal is a large organization in

which all knowledge workers have full context, tools, and support to focus their time on the biggest drivers of the business without being bogged down...That's exciting not only for the actual productivity gains that will result at an organizational level, but also for each employee who will finally have a clear sense of what matters and how to be successful"⁵⁴.

Suffice it to say, any tool that appears to threaten employee productivity would give a company's leadership pause. Because active workstations are often associated with movement and posture change before they are associated with work, many wonder if they negatively impact productivity/performance in the workplace. This section explores research that addresses active workstations in the context of productivity/performance.

Height-Adjustable Desks

Although evidence is inconclusive, studies suggest that height-adjustable desks have a neutral or positive impact on employee productivity/performance. Across relevant studies, productivity was measured objectively and subjectively. Objective measurements in the studies considered have limited potential for generalization since they specifically referred to aspects of productivity relevant to call centers. For example, a 2016 study at a call center measured productivity via call handling time and time spent concluding a call. However, these studies also measured more universal aspects of performance, such as attendance and sick leave⁵⁵. No significant changes in productivity outcomes were found for these objective measurements in these studies^{56, 57}.

Subjective productivity/performance measures were employed in all relevant studies, with most using selfreport surveys to poll respondents. For example, a study on height-adjustable desk usage at a Perkins+Will office asked participants to respond to statements like "there are no substantial obstacles at work to doing my job well"58. In this particular study, "65 percent of participants reported increased productivity after both six and 12 months" through self-reported measures⁵⁹. While this finding is initially impressive, this outlier sample is from an architecture and design firm, and thus respondents may have been more likely to report higher productivity since they may have been aware of perceived benefits of height-adjustable desks. However, positive or neutral results were reported across several other studies, with some also noting the physical benefits of height-adjustable desks: "A result... was a decreased level of discomfort...without having any adverse impact on the productivity indices"60. Notably, none of the studies included in this review found decreased employee performance or productivity as a result of using heightadjustable desks.

Treadmill Desks

While evidence supports the use of height-adjustable desks for facilitating productive behavior in the workplace, the impact of treadmill desks on productivity/performance is inconclusive^{61, 62, 63, 64}. Although the majority of studies found no significant impact on productivity, two recent studies suggest that treadmill desks may be better suited for reading comprehension and administrative tasks than tasks that involve extensive problem solving or frequent clicking or typing^{65, 66}. For example, a 2009 lab study found significant differences in performance between reading comprehension tasks and computer and math skills tasks. Researchers found that for participants in the treadmill condition, "scores on tests of typing and mouse proficiency, and math solving ability" were lower by approximately 6 to 11 percent compared to the sitting condition but did not find significant differences between the two conditions for reading comprehension or administrative tasks⁶⁷. Researchers hypothesize that this difference may be due to the increased load on mental processing and motor control when walking is paired with a fine motor movement or math, suggesting that these tasks "require a more complex interaction with cognitive abilities, and increased recruitment of attentional resources" compared to the attentional resources required for the administrative and reading comprehension tasks in this experiment⁶⁸.

However, field studies that measured performance and productivity in more general and subjective terms had more favorable results^{69, 70}. For example, a year-long experiment at a financial services company used self-report and supervisor surveys to capture productivity, and found positive performance effects for both employee and supervisor ratings. The authors acknowledged the limitations of this approach, but noted that their data is "consistent with the favorable effect of physical activity on performance found by other researchers using within-person design"71. In general, research suggests that treadmill desks have a neutral or favorable effect on overall workplace productivity/performance, but when an office job is drilled down into more specific tasks (e.g. prolonged typing, precise clicking, or complex problem-solving), walking on a treadmill desk may negatively impact performance on those specific tasks. Furthermore, several studies indicated an initial decline in performance while participants learned how to adjust to walking while working so experts suggest that training on the best tasks to perform while walking at a treadmill desks may shorten the adjustment and learning period.

3.3 Psychological Outcomes

While not predominantly associated with an effective workforce, psychological states and feelings play an integral role in employee effectiveness. Psychological outcomes can have positive or negative associations. For example, arousal is associated with productive coping responses, and task satisfaction refers to a pleasurable emotional state from completing a task. Both of these outcomes positively contribute to an individual's overall effectiveness at work, the logic being: if you feel good at work, you will be better equipped to perform your job responsibilities. Researchers have tested this logic in the lab, finding that positive feelings at work make people about 12 percent more productive⁷².

Conversely, outcomes such as boredom, often associated with distraction from work, or stress, which leads to mental or physical tension, are also common in the workplace, and have a detrimental effect on an individual's ability to perform their job. According to the American Psychological Association, job stress frequently causes burnout, which not only leads to "emotional exhaustion and negative or cynical attitudes" but can also lead to chronic depression, which is linked with a wide range of health concerns⁷³. This section discusses research on how active workstations have been studied in the context of the aforementioned psychological outcomes, examining whether the interventions help or harm how employees feel at work.

Height-Adjustable Desks

Compared to research on sedentary behavior and productivity/performance, research on how heightadjustable desks impact psychological outcomes is underdeveloped. Only two of the studies considered for this project addressed psychological outcomes, and both evaluated psychological outcomes as secondary variables. Furthermore, both studies measured psychological outcomes using self-report surveys modeled off validated psychological test measures.

Brewer found "enhanced [not statistically significant] workplace wellness," and also observed indications of psychological wellness through unstructured interviews with participants⁷⁴. For example, one participant remarked: "[The sit-stand desk] has made my post-lunch energy slump disappear"⁷⁴. Pronk observed more structured and statistically significant results, indicating that "the intervention group experienced significant improvements...for fatigue, vigor, tension, confusion,

depression, and total mood disturbance"⁷⁵. While initial results are promising, there is currently no conclusive evidence on the impact that height-adjustable desks have on psychological outcomes in the workplace.

Treadmill Desks

Similar to height-adjustable desk research, evidence on the relationship between treadmill desk usage and psychological outcomes is not fully developed. Only one study considered addressed this relationship⁷⁶. This lab study evaluated boredom, task satisfaction, stress, and arousal as primary outcomes using subjective survey questionnaires. For example, the Job Boredom Scale was utilized to ask participants questions like "Did the tasks go by too slowly?" and the Michigan Organization Assessment Questionnaire polled respondents on statements like, "In general, I liked this set of tasks"⁷⁶. Findings from this study suggest that participants in the treadmill desk condition experienced "higher satisfaction and arousal and experienced less boredom and stress" than participants in the seated condition⁷⁷. The authors of this study propose that these positive effects may be attributed to the variety that treadmill workstations adds to a workday78. Additional studies on the relationship between treadmill desks and psychological desks must be administered to determine generalizable effects, especially for long-term treadmill desk usage.

4.0 DISCUSSION

Overall, the 16 articles considered for this review make a case for implementing an active workstation program in the workplace. Preliminary evidence generally supports that active workstations have neutral or positive impacts on employee effectiveness outcomes like cognitive function, productivity/performance, and psychological outcomes. However, as most of the studies acknowledge, firm conclusions cannot be drawn because participant groups were generally small and demographically homogenous^{79, 80, 81, 82, 83}. Furthermore, many of the studies took place inside labs, with experiments imperfectly replicating workplace environments and tasks. While many of these experiments have been identified as appropriate substitutes for workplace tasks by experts, it is important to note that generalizability to the workplace is limited. For example, in many of the lab studies, participants were given specific tasks to complete in a set period of time, with no interruptions. This experimental design bears little resemblance to a typical office environment, where focus is often disrupted by colleagues, meetings, telephone calls, or breaks.

However, there were longer-term field studies that took place in actual offices^{84, 85, 86, 87, 88}, which may allow for greater generalizability. Notably, a few of these studies also included support strategies to train employees on the health benefits of using active workstations, which may have impacted utilization and perceived success of interventions from the standpoint of participants^{89, 90}. An interesting omission from these training programs was a lack of active workstation usage guidelines e.g. how long and how often height-adjustable or treadmill desks should be utilized, or which tasks are appropriate for active workstation use. Although none of the studies specifically address this omission, it may be due to a lack of scientific evidence to support such guidelines or recommendations. Since this review has identified task appropriateness as a key consideration for using the interventions, especially treadmill desks, such guidelines would be an essential part in making active workstation programs a success.

4.1 Limitations

The main limitation of this review is the small number of studies included for analysis. Because of this project's narrow focus (see section 1.1), many of the articles initially considered for review were eliminated. As the sedentary behavior and physical health impacts of active workstations continue to be established, the body of work on non-health implications of these interventions will likely be studied more rigorously.

4.2 Recommendations for Future Studies

None of the studies considered in this review were longer than a one-year period, and longer-term studies are necessary in order to examine employee effectiveness impacts beyond pilot periods. Echoing a systematic review on the impact of height-adjustable workstations and sedentary behavior, additional well-conducted and adequately powered randomized trials are necessary to determine the employee effectiveness benefits of active workstation use, both in the short and long term⁹¹. Furthermore, studies should be designed to help formulate evidence-backed guidelines for active workstation use to ensure the strategic and safe use of these interventions in the workplace.

5.0 CONCLUSION

This review acknowledges that the evidence on the relationship between active workstations and employee effectiveness is limited. Nonetheless, relevant data suggest that active workstations combat the ubiquity of sedentary behavior in the workplace without inhibiting employee effectiveness. If task appropriateness is taken into account, current evidence suggests that active workstations have a neutral or positive impact on employee cognitive function, productivity/performance, and psychological outcomes.

While there are several factors to consider when applying the results of these studies to the workplace, these studies form a compelling body of research that adds value to current understanding of how active workstations impact not only workplace sedentary behavior, but also employee effectiveness.

Acknowledgements

Thank you to Janice Barnes and Michelle Osburn, who provided essential guidance and support on this project.

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