

Workers Standing Times with Use of Sit-Stand Desks and Social Influences: An Investigation of Two Months of Office Workers' Sit-Stand Desks Utilization

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Abstract

The use of sit-stand desks (SSD) has shown positive results in reducing sitting time for office workers. Different factors can help with the use of the table, such as participatory ergonomics and an SSD reminder system. However, little is known about the influence of social factors at work, such as the influence of peers or supervisors using the device. The aim of this study was to investigate the use of SSDs and how the location and proximity of office workers affects SSD utilization over the course of two months. One-hundred eighty workers with SSDs participated in this study, and their desk locations and utilization were documented. It was observed that office workers spent on average (standard deviation) 7.1% (20.8%) of their time standing at their desks each day. Among these users, 12 participants were categorized as high SSD users, which spent more than two hours a day standing on average. It was found that during the study period, participants located next to high SSD utilizers did not change the SSD usage by increasing or decreasing their time spent standing. The results from the study suggest that the relative locations and proximity of workers do not significantly influence users to increase SSD use, and high users do not impact the SSD use of other users. These results showed that SSD use by peers or supervisors is not a strong social factor in improving the worker's behavior of using the table and that other combined strategies are necessary.

Introduction

Office workers are known to spend a substantial amount of work sitting, which contributes to worker sedentary behavior (Clemes et al., 2014; Hadgraft et al., 2016; Parry & Straker, 2013; Prince et al., 2019). Sedentary behavior is linked to both a higher risk for type II diabetes and increased mortality in adults (Biswas et al., 2015; Mansoubi et al., 2014; Thorp et al., 2011; van Uffelen et al., 2010). When considering these facts alongside the knowledge that workplace sitting accounts for nearly one third of an overall individual's sitting time, it is no surprise that several initiatives in reducing sitting time currently target the workplace to reduce sedentary behavior and increase overall physical activity (Jans et al., 2007; Shrestha et al., 2018).

One initiative that has been adopted by workplaces and has evidence of positive reductions in sedentary behavior is the use of sit-stand desks (SSD). SSDs are adjustable - often powered - tables that allow users to alternate between standing and sitting positions and keep working without impact in their productivity. Previous work has found that SSDs have been linked to reduced sitting time of up to 100 minutes per day without any deleterious effects on work performance (Neuhaus et al., 2014; Shrestha et al., 2018). However, this amount of time spent standing falls short of the expert

guidance of achieving two hours a day of standing and light activity in the short-term and four hours a day in the long term (Buckley et al., 2015). In addition, although SSDs were effective at reducing sitting time in the short term, their use will be reduced after three months (Shrestha et al., 2018). This reduction in the longterm exemplifies the need to understand combined strategies for prolong SSD use. Thus, macro ergonomic perspectives and considerations should be explored to understand what may maximize SSD benefits or even increase its use to prevent adverse health conditions.

When considering the use of SSDs among users, one component of SSDs that has received very little attention is the contextualization of SSDs in their social environments of use (Shrestha et al., 2018). Workers without a strong sense of individual identity within a group are more likely to change

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their opinions to fit into what they perceive to be the most popular opinion on a particular subject (Lee, 2019). This means that the standing time may increase if an individual were to see other team members using SSDs in a standing position. Groups, in office environments, will likely be formed based on cubicle proximity due to proximity principle. In addition to this, users who will not be guaranteed anonymity are typically more likely to conform to group opinions (Lee, 2019; Tsikerdekis, 2013). As a result, office workers outside of leadership roles that work within proximity of one another may experience unique influences of conformity that will impact their SSD usage. For example, users that observe their peers not standing may feel pressure to remain seated or vice-versa (Graves et al., 2015; Grunseit et al., 2013). These examples suggest that this aspect of social identity may not only be applicable to individual opinion, but also to an individual's actions. As a result, it may be possible to influence an office worker's SSD use through group identity. A study that evaluated organizational environments found that proximity to leaders may induce motivation and psychological ownership in company aligned goals in individuals (Ye et al., 2022). This proximity-induced motivation may potentially be observed with SSDs by group leadership where individuals may be influenced by local leaders to more frequently utilize their SSDs. Additionally, a second study found that individuals of high social reliability are also capable of inducing motivation (Bang & Frith, 2017). This motivation may also be possible in the context of SSDs if individuals of high social standing were to be observed using SSDs for long durations, as this may confer an advantage to group members in their decision-making process.

These ideas, however, largely rely on the assumption that this concept derived from social identity and proximity principle will hold due to a more uniform and conformed group of individuals. This is not to say that more diverse and functional groups would not come to the same decision to use SSDs for prolonged amounts of time. In fact, more diverse groups may arrive at the same conclusion by harnessing the *wisdom of crowds* (Bang & Frith, 2017). This is a contributing reason as to why it is paramount for workers to receive ergonomics training in order to encourage the proper and continuous use of SSD (Robertson et al., 2013).

The aim of this study was to conduct an exploratory study to examine the impact of the proximity of office workers on the frequency of SSD utilization. The goal of this study was to document the longitudinal use of SSDs by office workers and to examine if standing patterns changed depending on the proximity of high users.

Methods Study Population

This study was approved by the Washington State Institutional Review Board. Participants gave informed consent and were allowed to withdraw from the study at any point. In total, 180 participants from a large government agency participated in

the study. These office workers performed computer-based tasks and were mostly bonded to their desks throughout the workday, except for breaks, minor errands, or meetings that took place in conference rooms.

Procedure

Participant workstations were equipped with an electric sit-stand desk (UPLIFT, version 2, UPLIFT DESK, Austin Texas). Each participant sat at an L-shaped layout where one part of the L contained a standing desk received in prior years as part of a furniture overhaul. An interface was also developed and integrated between the SSD and the user's computer, to track SSD usage based on the user's interaction with the computer and the SSD controller (Wellnomics, Christchurch, New Zealand). The time spent with SSD in low and high positions was used as a proxy for how long the workers spent in sitting and standing positions. Participants were asked to use the desk at their own discretion and were not given a specific pre-set time to follow.

Deidentified participants' desk numbers, desk locations, and primary manager were noted as potential social groupings for the study. There were 60 days of data collection periods spanning from January 1, 2020, to February 29, 2020. Each day, participants' standing and changes in posture were recorded through the SSD controller system. The data collection for each day began with the activation of their computer and ended with the shutdown of their computers.

Metrics

Participants sitting and standing durations were recorded for each day of use. Each desk controller had a set height threshold based on the user's preference to determine whether the desk was in standing or sitting mode. Postural changes were counted and defined as changes in desk height lasting over 5 minutes or when the computer idled for longer than 10 minutes. Participants with 2 hours or more/day of SSD use were defined as high users based on the recommendation of SSD use (Buckley et al., 2015).

Group Mapping Analysis

Participant groups were created by combining the already present cubicle numbers with building floor plans. Groups were assembled based on cube proximity which was defined as participants who shared the same cubicle "island" which refers to groups of desks that share cubicle walls (Figure 1). A total of 87 groups by proximity were created.

Participants were also grouped based on their line of sight on other cubicles. These groups were created in a similar fashion to the groups by proximity. Line of sight was defined as the cubicle sharing a hallway with an adjacent cubicle "island" in question with no interior or exterior walls blocking vision (Figure 1).



Figure 1. Floor Mapping Procedures Visualized with Grouping Example and High SSD Use Cubicles groups.

Analysis

Data without SSD use (participants missing both sitting and standing times) during the study period were removed, as this indicated that they either didn't work at their desks or their desk malfunctioned. For the grouping by proximity analysis, participants that did not have a recorded desk location were not included. Location groupings composed of a single person were removed.

Since the study participants' locations spanned four different floors of the office building, cross-comparisons were completed for each desk grouping type within each floor. Groupings that did not exist on the same floor were not compared against each other unless supervising groupings crossed multiple floors.

Due to the emergence of the Coronavirus disease (COVID-19) pandemic, study participants switched from office work environment to remote work; therefore, this study includes two months of data. Data was analyzed using RStudio version 4.2.2 (RStudio, Boston, MA). ANOVA analyses were conducted across the different desk groupings and across the different line of sight groups.

Results

A total of 102 office workers data were utilized for the desk grouping analysis. Workers in total spent an average of 7.1 (20.8) mins % of their time standing at their desks a day.

Twelve participants were categorized as high SSD users; these are workers that reached a minimum of two hours of standing time during the workday. Nine out of the 12

Table 1. Number of desk utilizers for each group on Floor 4.

Desk Groups	High Utilizers	Non-High Utilizers
23, 29, 35, 43, 73	1	2
26, 50, 52, 61, 63, 69, 70	0	3
27, 28, 31, 33, 34, 44, 56, 59, 64, 66	0	2
41	1	5
55, 60, 65	1	4
62, 67	1	3
68	0	5

participants were documented to exceed the 2-hour threshold for multiple days. Each high SSD user belonged to a different desk grouping. When looking at floor 4 there were a total of 11 desk groups with at least one high utilizer and 18 groups without a high utilizer (Table 1). When comparing higher utilization groups (Figure 2A) against non-high utilization groups on floor 4 (Figure 2B), high utilization groups on average spend 25.3 min (13.4%) of their time standing while groups with no high utilizer in them spent 4.0% of their time standing (high users not included in the analysis to prevent skewing) ($p < 0.01$). The average high-utilization users standing percentage stays above 176.7 min (55%) for most days while the average standing percentage for non-high-utilization users stays 11% and below (Figure 3).

There was no significant difference when comparing the multiple line-of-sight groups ($p > 0.05$). Out of the 68 original visual groups mapped, only 19 of them were used

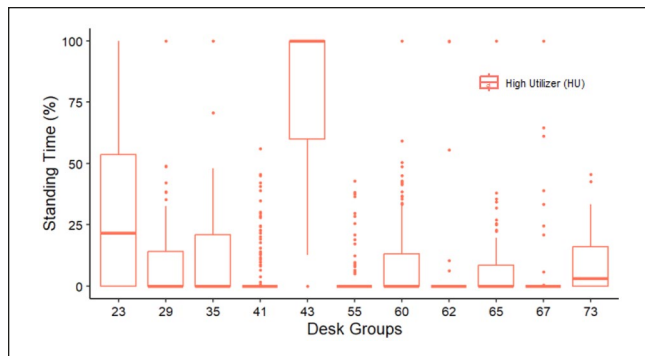


Figure 2A. Average percent standing per participant for each desk group with a higher-utilization user on floor 4.

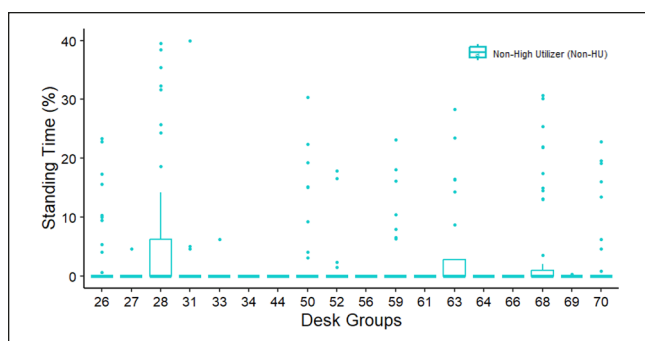


Figure 2B. Average percent standing per participant for each desk group without a higher-utilization user on floor 4*33 outliers removed.

(containing participants with recorded desk usage) (Table 2). The majority of visual groups were out on floor 4 with 16 visual groups. When comparing the percent standing times for each group it was found that there was only two in line-of-sight groups that had significant SSD use time ($p < 0.05$). Comparisons of standing time based on floor location found that there was no significant difference between any groups ($p > 0.05$).

Discussion

It was found that even with the presence of SSDs in the work environment this was not the case with the overall average percentage of standing time at 12 min (7.1% of time at desk) during the workday. A possible explanation for why workers rarely used the table was that workers use the table freely. Workers were not given a specific schedule to follow. In this case, there is a potential for future programs to guide the use of the table for this population. Furthermore, the SSDs were initially implemented in the office space before data collection began, as a result, workers have had ample time to grow accustomed to the presence of the SSDs. This also lines up with the literature, as reduced use is observed in the long-term after 3 months of use (Shrestha et al., 2018).



Figure 3. Average utilization groups' percent standing per participant for each day. High SSD utilizes was those who spent more than 2 hours of the workday in a standing position.

Office workers in desk groups with high utilization users did not increase or change their SSD habits. Although these high-frequency users were within proximity and line of sight of other users, they were not tasked with engaging with other users in a more active leadership role or reporting their usage to each other. No targeted interventions or conversations took place, which means that adjacent users did not receive information or a clear model, action, or consequence outline to follow, which are all critical components to prolonging or incentivizing the use of SSDs (Shrestha et al., 2018). A simple intervention of reminding office workers about the importance of proper office health practices would have helped improve standing times. It was shown that the workers in a particular study that used an SSD integrated with an orientation and reminder system for four months presented a lower average of 239.2 (± 42.2) min/worktime than a control group with 262.4 (± 58.8) min/worktime (Ma et al., 2021).

These findings highlight the criticality of selecting factors of SSD that involve direct intervention and education for the prolonged use of SSDs. Perhaps if high SSD users were tasked with holding frequent meetings or discussions on the benefits of SSDs then there may have been some correlation between adjacency to these high SSD users and the rest of the worker population. These findings are supported by the current literature which emphasizes the importance and efficacy, in the short-term, of multicomponent interventions (Danquah et al., 2017; Healy et al., 2013; Maylor et al., 2018). Based on these results, it is possible to say that only the presence of an SSD in an office environment can have limited effects, whether on the individual or social level. Therefore, we suggest the combination of the SSD use with multiple strategies aiming to reduce the sedentary behavior of the office workers and educate office workers on the importance sedentary behavior reduction (Danquah et al., 2017). To this end, it is also important to note that the 2-hour

Table 2. ANOVA line of sight groups comparison p-values.

Visual Groups	Floor	Desk Groups	Average Standing (%)	p-value
1	2	1 -2	18.5	0.83
2	2	2 -3	17.9	0.92
18	4	26 - 27	13.2	0.37
19	4	28 - 27	22.3	0.19
20	4	28 - 29	24.3	0.88
22	4	29 - 31	11.3	0.61
25	4	33 -34	1.3	0.50
31	4	43 -44	46.4	0.03
40	4	56 - 58 -55	14.5	0.12
45	4	60 -61	30	0.01
47	4	63- 64	16.1	0.39
48	4	62 - 63 - 64 - 65	23.1	0.61
49	4	64 - 65	15.3	0.31
50	4	65	15.3	0.31
51	4	66 - 67	30	0.23
52	4	67 - 68	24	0.13
53	4	68 -69	15.3	0.28
54	4	69 - 70	16	0.20

recommendation used for the data analysis may be a higher target to classify high users, as previous studies found a lower average of reduced sitting times at 100 minutes per day for most SSD interventions (Neuhaus et al., 2014; Shrestha et al., 2018).

Limitations

Limitations of this work include limited data due to data collection being interrupted by the rise of COVID-19. As a result, some participant data is missing during the final two weeks of February due to office workers leaving the offices for health-related factors and mandatory work-from-home orders. Furthermore, documentation on SSD utilization was limited due to the data being collected by the SSD controller: it is possible that the standing reported included times away from the desk, where participants may have been standing or engaged in activities elsewhere. This limitation of the desk coding dictating the way data was collected could have influenced the standing times reported as times participants were away from their desk would have influenced these results. Having participants give a better narrative of their activities during the day and when they used their desk could have helped us gather a better picture of how the desks were used.

Conclusion

It was found that most office workers spent the majority of time in sitting position and, the traditional office social influences (neighboring workers, desk locations) were not able to influence individuals or groups of office workers to increase their SSD usage. Even though this study was interrupted due

to the emergence of the COVID-19 Pandemic it still provides a good insight into the social dynamics of the office environments when it comes to integrated health-improving changes. We support the idea that the use of SSD is a resource with limited effects, and that several strategies should be adopted to combat prolonged sitting time. With the proper integration of SSDs they could provide a potential solution to prolonged sedentary behavior in the office work environment.

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