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Effects of Active Sitting on Reading and Typing Task Productivity

CLAIRE E. DOROFF*[1], EMILY L. LANGFORD†[1,2], GREG A. RYAN‡[1], and RONALD L. SNARR‡[1]

[1]Department of Health Sciences and Kinesiology, Georgia Southern University, Statesboro, GA, USA; [2]Department of Kinesiology and Health Promotion, University of Kentucky, Lexington, KY, USA

*Denotes undergraduate student author, †Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 12(5): 1216-1224, 2019. Increased sedentary behavior and reduced physical activity among children and adults has led to the advent of various active devices to combat these behaviors. Active sitting, consisting of modified chairs or stability balls, allows the body to stay dynamic while seated. While research has evaluated the health benefits of active sitting, minimal research has shown the effects of active sitting on productivity in adult populations. The purpose was to evaluate the effects of various chairs (active versus non-active) on typing and reading task productivity. Twenty adult participants performed typing and reading tasks for 10-minutes while sitting on each of the following: standard chair (SC), stability ball (SB), and active sitting chair (ST). Reading comprehension (RC), words per minute (WPM), accuracy, and errors were measured following each task. Additionally, perceived productivity was measured using a self-reported rating of difficulty scale (1-10). In terms of RC, there was no difference between the chairs ($p = 0.16$). However, perceived productivity was significantly greater on the SC as compared to SB ($p < 0.01$) and ST ($p < 0.01$). For the typing task, no differences were demonstrated for errors ($p = 0.87$) or accuracy ($p = 0.91$). However, WPM was significantly greater on SC (38.8 ± 10.5) compared to ST (35.9 ± 9.5) ($p = 0.02$). For perceived typing productivity, SC and SB demonstrated significantly greater values compared to ST ($p < 0.01$). Results suggest that various types of active sitting may have a minimal negative effect on workplace performance and perceived productivity.

KEY WORDS: Prolonged sitting, stability ball, ergonomics, sedentary behavior

INTRODUCTION

Due to technological advancements in the workplace and transportation, sedentary behaviors have become a national health concern. Prolonged bouts of sedentary behavior, or any task resulting in extended periods of inactivity, have recently been linked to serious health risks, including diabetes and cardiovascular disease (20, 22). For this reason, national public health priorities have shifted to reducing prolonged sitting time instead of solely promoting daily physical activity.

Commonly used methods to reduce sitting time include implementing a daily step count or incorporating regular activity breaks. However, evidence suggests that these methods may not be effective at reducing overall sitting time (3). Therefore, active workstations have become a favored alternative in workplace settings. These active workstations allow for movement while in either a standing (e.g., sit-to-stand desks, treadmill desks) or seated (e.g., cycling desks, stability balls, active sitting chairs) position. Furthermore, these apparatuses have shown to be effective in increasing calorie expenditure, energy levels, and posture (2, 18); thereby, promoting increased movement and physical activity throughout a given workday. In addition to the physical effects of prolonged sitting, recent research suggests sedentary behavior may affect productivity outcomes as well (6). This research has been conducted in various populations including students with and without disabilities, as well as typical office workers, with most studies indicating changes in productivity are dependent on the task performed (7,11,12,13,14,21).

For example, Mehta, Shortz, and Benden (12) found when using standing desks in 9th grade classrooms, students showed a 7-14% improvement in executive function and working memory over the course of one year. Moreover, the replacement of standard desk chairs with stability balls was shown to be effective at improving classroom performance, and in some instances, superior to taking activity breaks (7, 11). The constant minor postural adjustments needed while on a stability ball may increase attentional focus, which could in-turn increase productivity (17).

Additionally, a recent systematic review by Ojo and colleagues (14) sought to determine the effect of active workstations (i.e., sit-to-stand desks, treadmill desks, cycling desks) on productivity in adults, and ultimately concluded no detriment to the performance of workplace tasks. While this appears to be the case for cognitive tasks, such as reading comprehension, motor tasks may be more severely affected by the introduction of activity. For example, Ohlinger et al., (13) had participants complete tests of divided attention and short term auditory verbal memory (i.e., Auditory Consonant Trigram test), selective attention (i.e., Golden Stroop Color and Word test), and a simple motor skill (i.e., Digital Finger Tapping test) while seated, standing, and walking on a treadmill desk. Results indicated minor impairment performing motor skills while walking on a treadmill, but no decrements on memory or selective attention, with no differences between the standing and sitting conditions. Additionally, workplace motor tasks (i.e., typing speed) have also been demonstrated to be affected (i.e., decreased by 9-16%), while using active workstations (10, 21).

While there is sufficient literature examining the effects of active workstations on productivity, very little exists specifically in regard to active sitting in adult populations. Of the previous literature found, many utilized products such as treadmill or cycling desks. However, these products can be costly and unfeasible in an office setting. Therefore, the purpose of this study was to investigate the effect of a standard typical office chair, a stability ball, and a novel active balanced sitting chair on reading comprehension and typing productivity. Based on previous findings with active workstations, it was hypothesized that no differences in productivity would exist during reading comprehension tasks. Whereas, due to required motor control associated with maintaining balance, typing task productivity may be altered for individuals when seated on either a stability or active sitting chair.

METHODS

Participants

Twenty healthy adults, consisting of five males and fifteen females, agreed to participate in this study. All descriptives for participants are reported in Table 1. Sample size calculations, using a repeated measures F-test design via G Power software (Heinrich-Heine University of Dusseldorf, Dusseldorf, Germany), determined 18 participants would be needed to obtain statistical power. A power level of 0.8, alpha level of 0.05, and effect size of 0.55 based on a meta-analysis of previous research with similar methodological designs were used to calculate the sample size (1). To be considered eligible for this investigation individuals must have been between the ages of 18-45 years and free from any underlying cardiovascular, neurological, or metabolic conditions. This study was approved by the university institutional review board prior to all testing, and written informed consent was obtained from each participant. Additionally, this research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science.

Table 1. Descriptive statistics of the study participants

	Men (n = 5)	Women (n = 15)	All (n = 20)
Age (yr)	27.8 ± 8	26.2 ± 7.9	26.8 ± 7.9
Height (cm)	179.8 ± 4.9	165.0 ± 5.4	168.1 ± 8.2
Body mass (kg)	90.4 ± 14.2	63.7 ± 7.7	69.9 ± 15.2
BMI (kg/m^2)	28.1 ± 5.1	23.4 ± 2.9	24.5 ± 3.9

BMI = Body mass index

Protocol

Participants completed two separate days of randomized testing in the Human Performance Lab, with each visit dedicated to either a reading or a typing task. After completing all paperwork, height and weight were obtained using a standard stadiometer and a digital scale. Participants were then given a five-minute familiarization period on each of the following chairs: stability ball (SB), standard chair (SC), and active balance sitting chair (ST) (SitTight™, SitTight, Inc., Las Vegas, NV, USA). The familiarization period was to ensure that participants were comfortable with the unstable nature of the ST chair, as the design of the device is meant to consistently initiate movement. All subjects were successfully able to use the active sitting chair correctly within the five-minute period. These procedures are consistent with previous research by Snarr et al. (19) which examined cardiovascular and metabolic responses to active sitting. Following familiarization, participants completed the simulated workplace task (i.e., reading or typing) for a duration of 10 minutes. This process was repeated with each chair condition in a randomized fashion. While on the SB and SC, participants were instructed to sit upright with feet planted on the floor (Figure 1a, b). On the ST, however, individuals were instructed to rest feet on the outer ledge and balance their center of mass as best able, so the ledge was not resting on the ground (Figure 2a, b). Before testing, the height of the ST was adjusted to allow for a standardized position (i.e., knees bent at 90 degrees).

Figure 1a. Standard Chair (SC)

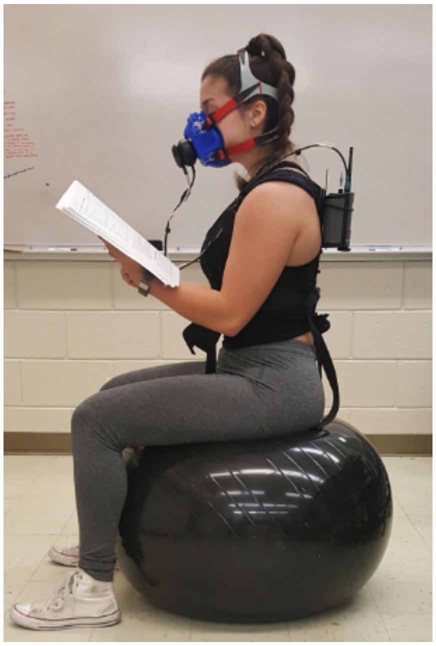

Figure 1b. Stability ball (SB)

For the typing task, a laptop was positioned at a self-selected distance, and participants were instructed to avoid resting their wrists on the computer or desk for stabilization. Words per minute, errors, and accuracy were measured as participants followed 10-minute excerpts from a series of pre-selected novels. For the reading task, participants were instructed to read standardized testing style prompts with the intention of answering a series of corresponding comprehension quizzes. A different, randomized prompt containing two excerpts was given for each condition, and quizzes were graded to quantify productivity while reading.

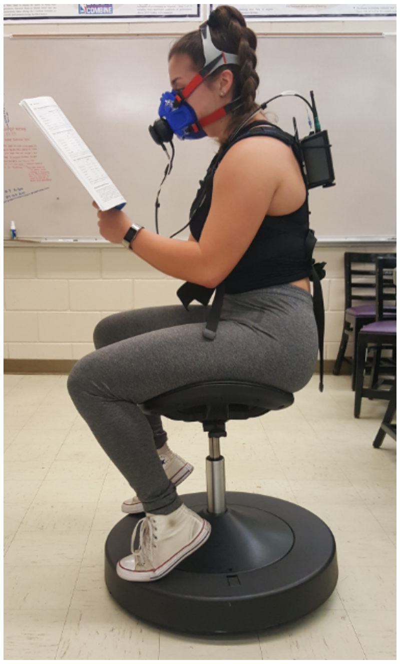

Figure 2a. Active sitting chair (ST)

Figure 2b. Proper positioning of ST chair (i.e., balanced in middle).

Following completion of each trial, participants were instructed to rate their perceived productivity using an OMNI Scale and a Visual Analog Scale (VAS). The OMNI scale was scored where a rating of 0 indicated "no productivity at all" and a 10 indicated "maximal productivity". For the VAS, participants were asked to denote productivity by marking a vertical line on a 0-100 millimeter scale, where productivity increased as the line approached 100. VAS has been previously utilized within various populations to assess the effect of a given variable on work task productivity (8, 16).

Statistical Analysis

All statistical analyses were performed using a statistical software package (SPSS version 25.0; IBM, Somers, NY, USA). Statistical analysis for words per minute, errors, accuracy, and reading comprehension was performed using one-way repeated measures ANOVA. Due to the ordinal nature of the OMNI scale, significant differences in perceived productivity for typing and reading tasks were assessed using a Friedman's ANOVA. A Cohen's d statistic (4) was calculated as the effect size of the differences and Hopkin's scale of magnitude (9) was used where an effect size of 0-0.2 was considered trivial, 0.2-0.6 was small, 0.6-1.2 was moderate, 1.2-2.0 was large, > 2.0 was very large. Statistical significance for all comparisons was set at an alpha level of 0.05. Tests for normality including skewness, kurtosis, histogram analysis, and Shapiro-Wilks.

RESULTS

All data are displayed as means ± SD (i.e., VAS, WPM, accuracy, and typing errors) or medians and interquartile ranges (i.e., perceived productivity). Due to either the skewed or kurtotic nature or non-normal distribution of the dependent variables, non-parametric statistics were used to compare reading and typing task outcomes between chair conditions.

In terms of reading comprehension, a Friedman's ANOVA determined there were no differences between the chair conditions ($p = 0.38$). However, significant differences in perceived productivity, using the OMNI scale, were found between SC (Mdn: 8 (IQR: 6-9)) and SB (Mdn: 6 (IQR: 5-8)) ($p = 0.02$; $d = 0.52$), SC and ST (Mdn: 4 (IQR: 3-6)) ($p < 0.01$; $d = 1.53$), as well as SB and ST ($p < 0.01$; $d = 0.96$). For the VAS, during the reading task, significant mean differences existed between all conditions ($p < 0.01$). The SC (68.92 ± 21.08) was significantly greater than both SB (57.24 ± 22.21; $p = 0.02$; $d = 0.54$) and ST (38.42 ± 23.55; $p < 0.01$; $d = 1.36$). Additionally, there was a significant statistical difference between the SB and ST ($p < 0.01$; $d = 0.82$).

For the typing task, statistically significant differences were observed for WPM between SC (41.79 ± 13.22) and ST (37.42 ± 11.57; $p < 0.01$; $d = 0.35$), as well as SB (40.47 ± 12.28) and ST ($p = 0.03$; $d = 0.26$). No difference was observed between SC and SB ($p = 0.13$). Regarding typing errors, no differences ($p = 0.14$) were demonstrated between the SC (148.68 ± 138.17), SB (128.26 ± 113.29), and ST (163.53 ± 135.31) conditions. Additionally, there were no statistically significant differences ($p = 0.35$) within accuracy for SC (64.19 ± 32.73%), SB (63.51 ± 31.67), and ST (53.91 ± 35.13).

In terms of perceived productivity, SC (Mdn: 7.5 (IQR: 7-9)) demonstrated a significantly greater value when compared to ST (Mdn: 4 (IQR: 2-4)); $p < 0.01$; $d = 1.63$); whereas, SB (Mdn: 7 (IQR: 5-8)) was also significantly greater than ST ($p < 0.01$; $d = 0.96$). No difference existed between SC and SB ($p = 0.11$). For the VAS, during the typing task, significant mean differences existed between the conditions ($p < 0.01$). The SC (69.63 ± 16.70) was significantly greater than the ST (36.08 ± 24.12; $p < 0.01$; $d = 1.62$). Additionally, there was a significant difference between the SB (59.87 ± 22.79) and ST ($p < 0.01$; $d = 1.01$). There was no difference between SC and SB ($p = 0.11$).

DISCUSSION

Due to recent public health initiatives to reduce sedentary behaviors, the invention of various active workstations has arisen as a means to stay active during the work day. While these workstations have shown to improve multiple health metrics (e.g., blood pressure, lipid profiles, body composition) (23), the effect on productivity is still uncertain. Moreover, little previous literature evaluates the use of active balanced sitting compared to traditional work stations. Therefore, the purpose of this study was to examine the effects of a standard chair, a stability ball, and active balanced sitting chair on typing and reading task productivity.

Consistent with the hypothesis, results of this investigation indicated no significant difference in productivity during reading tasks across all chairs. However, perceived productivity was significantly lower on the SB and ST than on the SC. This indicates that while participants were equally as productive, perception of reading comprehension performance was hindered utilizing an active workstation. In contrast, during the typing tasks, a significant decrease (i.e., ~10%) in words typed per minute was observed between the ST and the SC. However, no statistical differences were observed within the number of errors or accuracy between chair conditions. Furthermore, while no differences existed between perceived productivity on the SC and SB, participants ranked productivity significantly lower while on the ST.

These results are consistent with those from John et al. (10), which demonstrated significant decreases in typing performance while using an active workstation. While the ST or SB was not examined, researchers compared performance of workplace tasks while seated to walking (i.e., 1 mile/hour) on a treadmill desk. This study assessed a variety of skills, such as selective attention and processing speed (i.e., Stroop Color and Word Test), fine motor movement performance (i.e., typing and computer mouse proficiency tests), and cognitive function (i.e., graduate record exam practice math and reading comprehension tests). No differences were observed in reading comprehension, processing speed, or selective attention between the seated and walking conditions; however, in the seated condition, typing speed was 9% faster and participants performed better on the mouse clicking task. While the previous study found increases in typing speed during seated tasks, this is inconsistent with the current findings of a reduction of ~10% WPM during active sitting. Similarly, Thompson and Levine (21) reported no differences in transcription accuracy, but a 16% reduction in typing speed while walking on a treadmill desk.

Furthermore, the current findings align with Ohlinger et al., (13), which investigated performance on tasks requiring memory, attention, and motor control while sitting, standing, or walking at an active workstation. Researchers found that when participants completed two cognitive and one motor control task for each condition, there were no significant differences for cognitive tasks. However, consistent with the current findings the active workstation resulted in a reduced performance in the motor control task compared to the seated and standing conditions.

Given these results, it appears active balanced sitting is similar to other forms of active workstations, in which constant postural adjustments may not interfere with cognitive tasks, but may affect fine motor skills (e.g., typing). This study, combined with the results from the aforementioned studies, lend support to the theory of attention. Within this theory, cognitive resources are shared causing; thus, interference in perceptual or executive pathways may occur when multiple tasks are performed simultaneously (15). Therefore, multitasking may cause both activities to have less attention than required, causing performance decrements (5).

Possible limitations of this study include the relatively short periods of evaluation. For instance, after chronic usage, individuals may become accustomed to the active balanced sitting chair; thus, improving typing or reading performance to the comparable level of using a standard office chair. Future research may benefit from examining productivity while on an active sitting chair over time. Furthermore, the population examined in this investigation was a convenience sample and consisted of a majority of physically active students and faculty, allowing for the possibility that participants were more physically fit than the general population. Less physically fit individuals may find active workstations more challenging and may not be able to complete similar tasks with the same proficiency. Provided overweight or obese individuals may find active sitting particularly appealing for the health benefits, future research should observe productivity among this population.

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