Reading Comprehension While Sitting Versus Walking

Original Research

Fred Miller III[1], Lydia Baker[1], Kalaina Stephens [1], Yenly Londono Calle[2]

[1]*Huntington University, Huntington, Indiana/USA*
[2]*Parkview Huntington Hospital, Huntington, Indiana/USA*

Open Access

Published: February 11, 2025

Research in Psychology and Behavior: *2025, Volume 5 (Issue 1): 2*

ISSN 2831-6738

Abstract

Introduction: Sitting jobs among American workers have increased. The purpose of this study was to determine if walking (vs. sitting) impacts reading comprehension.
Methods: Participants included 40 college students (17-24 years, 22 males and 18 females), eight non-athletes and thirty-two athletes. Testing took approximately 30 minutes per participant. Heart rate was measured utilizing a watch, and reading comprehension was determined using an online test. Paired t-tests determined statistical differences in reading comprehension, total test time, and heart rate.
Results: No significant difference was found in reading comprehension while walking (2.0 ± 1.55) and sitting (2.65 ± 1.55, $p = 0.053$). Heart rate was significantly higher during walking than sitting (BPM = 89.5 ± 14.51 vs. 79.4 ± 13.58, $p< 0.001$). Time to complete the reading comprehension test was significantly lower during walking vs. sitting (289.8s ± 78.94 vs 346.3s ± 123.44, $p < 0.001$).
Conclusions: Walking on a treadmill did not significantly affect reading comprehension compared to sitting. However, differences were approaching significance ($p = 0.053$), indicating a trend towards lower reading comprehension scores while walking. Heart rate was lower while sitting vs. walking, as expected. In contrast, participants completed the reading comprehension test faster while walking.

Key Words: Workstation, productivity, health benefits

Corresponding author: Fred Miller III, fmiller@huntington.edu

Introduction

The rates of overweight and obesity among adults and children have almost tripled since 1975.[1] One possible reason for this increment is a sedentary lifestyle.[1] Sedentariness not only increases one's risk of becoming overweight and obese but also other health problems such as increased cardiovascular disease incidence, cancer, type 2 diabetes, and all-cause mortality.[2] Furthermore, prolonged sitting can also negatively impact cognitive function. For example, Tremarche et al. [3] observed that students engaged in more hours of physical education scored higher on standardized reading tests. However, in a systematic review by Wassenaar et al. [4], they concluded mixed results on the effects of physical activity on cognitive functioning and stated that this field of research needs improved study quality. In addition, a study by Alderman et al.[5] examined the effects of walking at a self-selected speed and found no significant differences between walking and sitting conditions for any of the cognitive tests.

One solution to decrease sedentary behavior without increasing the time to exercise is via an active workstation. The positive aspect of an active workstation is increased physical activity while working. Torbeyns et al.[6] reviewed 32 active workstation studies and found overall active workstations decreased sitting time, increased energy expenditure and positively affected several health markers. Furthermore, Torbeyns et al.[6] found that active workstations had no

detrimental effect on work performance or acute effects on cognitive function. However, other studies reported mixed results when comparing work productivity, specifically between walking on a treadmill and sitting. For example, Dinesh et al.,[7] compared a treadmill workstation with sitting on various office desks tasks. They concluded that walking vs. sitting resulted in a 6% and 10% decrease in fine motor skills (e.g., mouse-clicking, typing speed) and math problem solving, but did not find a difference in processing speed or reading comprehension. High physical activity levels have been linked with better brain structures and functions. Miller et al.[8] examined the caloric expenditure and typing speed among sitting, standing, and walking. They found caloric expenditure was significantly higher for walking versus sitting and standing, and they also found that typing speed was significantly higher while standing compared to both walking and sitting. Typing speed was not significantly different between walking and sitting.

The increased sedentary behavior and rates of obesity warrant some solutions. One strategic solution is using an active workstation for desk jobs, thus reducing sedentary time without negatively impacting work productivity. Thus, the purpose of this study was to compare reading comprehension while sitting versus walking. It was hypothesized that increased physical activity (via heart rate measure) would be higher while walking than sitting and that no differences would be found in reading comprehension.

Methods

Participants

Forty college male (n = 22) and female (n = 18) students participated in the study. Of the 40 participants, eight were non-athletes and 32 athletes from varying sports teams. After arriving for testing, the participants read a consent form that explained the study's purpose, method, benefits, and risks. After an opportunity for questions to be asked, subjects agreed to participate by signing the consent form. This study was approved by the Huntington University Institutional Review Board (IRB) before testing.

Protocol

This study was conducted between October 2023 and November 2023. Testing took place on the university campus in the Science Hall Lab. The participants completed two reading comprehension tests in about 30 minutes. This study was a crossover design. Thus, half of the participants began in a seated position, while the other half started by walking on a treadmill. Most participants mentioned that they had never used an active workstation. An Apple watch (series 3) was placed on each participant's wrist to measure heart rate. The treadmill speed was set at 1.5mph. The speed was based on other studies. Also, this low speed was chosen to prevent falling. While sitting and walking, participants completed a short reading comprehension test, which included reading a short article (325 or 326 words) and answering seven multiple-choice questions about the article. The first two articles and questions were from the Test Prep Review (https://www.testprepreview.com/modules/reading1.htm). A multiple-choice test was chosen to assess reading comprehension as it is a common and efficient method utilized in schools and universities. Total time was recorded with a stopwatch and included when the participants began reading the article until they answered the last question. Following the test, the participant rested briefly for about five minutes and then commenced reading the second article while sitting if their first position was walking or walking if their first position was sitting. After the second reading comprehension test, the participant was finished and thanked for their time and participation in the study.

Statistical Analysis

Descriptive statistics (i.e., means and standard deviations) and inferential testing were performed in Excel. A paired two sample for means t-tests were used to determine statistical differences between sitting and walking for heart rate, reading comprehension, and total time to complete the test. Statistical significance was set at $p \leq 0.05$ for t-tests.

Results

The participant characteristics are presented in Table 1.

Table 1. Participant characteristics.

	ALL (N=40)	MALE (N=22)	FEMALE (N=18)
AGE (YRS)	20.1 ± 1.26	20.0 ± 1.46	20.2 ± 1.00
HEIGHT (CM)	173.9 ± 12.28	181.6 ± 10.39	164.5 ± 6.55
WEIGHT (KG)	69.5 ± 12.36	75.3 ± 11.89	62.4 ± 8.89
BMI (KG/M²)	22.8 ± 2.16	22.7 ± 1.81	23.0 ± 2.56

Note: values are mean ± SD; BMI = body mass index.

Descriptive statistics for reading comprehension, heart rate, and total time testing are displayed in Table 2. A paired two-sample for means t-test showed no significant difference ($p = 0.053$) between sitting and walking test scores. A significant difference ($p < 0.001$) was found for heart rate and total time testing ($p < 0.001$) between sitting and walking. Figure 1 below shows the reading comprehension scores for each participant while sitting versus walking.

Table 2. Reading Comprehension, heart rate, and total testing time in each position.

	SITTING (TEST 1)	WALKING (TEST 2)
READING COMP (OUT OF 7)	2.65 ± 1.55	2.0 ± 1.55 [-0.01,1.31]*
HEART RATE (BPM)	79.4 ± 13.58	89.5 ± 14.51 [6.63, 13.62]**
TOTAL TIME TESTING (SEC)	346.3 ± 123.44	289.8 ± 78.94 [26.55, 86.40]***

Note: values are mean ± SD; *p =0.053, **p < 0.001,***p < 0.001; 95% C.I. [lower, upper]

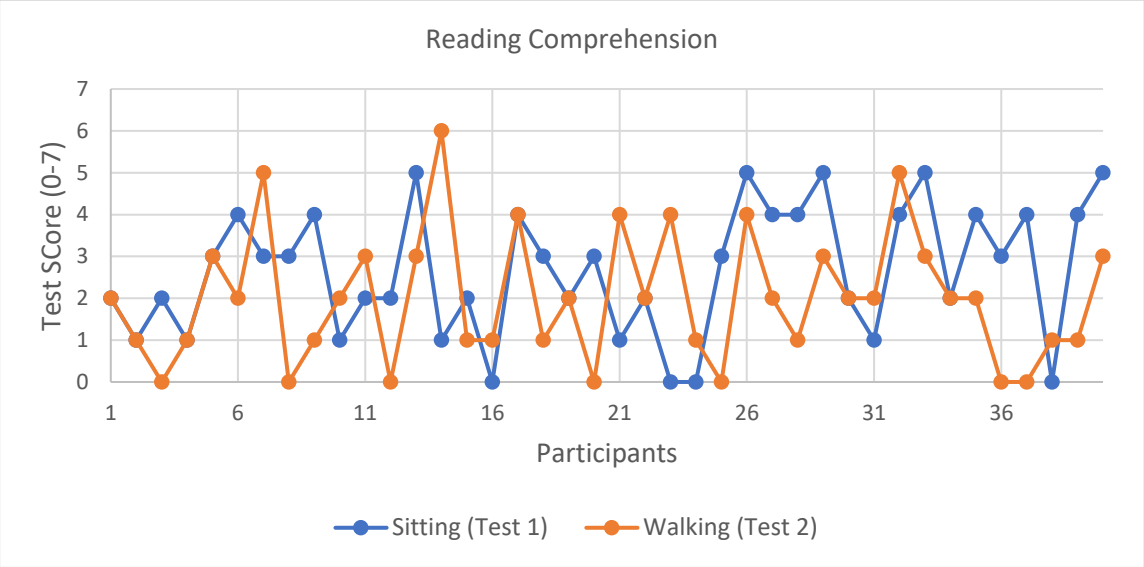

Figure 1. Reading comprehension scores while sitting vs. walking for each participant.

Discussion

Sedentary time and rates of obesity have increased over the past decades.[1] Increases in both have been linked to many chronic conditions.[2] One possible solution to reducing sedentary behavior and thus the rates of obesity and chronic diseases is through an active workstation. However, active workstations may negatively impact work productivity and, therefore, would not be suitable for desk jobs. Thus, the purpose of this study was to compare one aspect of work productivity (reading comprehension) while sitting and walking (active workstation). We hypothesized that walking would result in a significantly higher heart than sitting and that reading comprehension would be similar to sitting. We found that heart rate was significantly higher during walking versus sitting (89.5 vs 79.4 bpm) and that reading comprehension (based on test scores) was not significantly different (sitting = 2.65 vs. walking = 2.0, $p = 0.053$). A significant difference ($p < 0.001$) was found for total time testing between sitting and walking. Participants completed the reading comprehension test about a 1 minute (56.5s) faster while walking versus sitting (289.8 vs. 346.3s).

Dinesh et al.[7] compared a treadmill workstation with sitting and found that walking vs. sitting resulted in a 6% and 10% decrease in fine motor skills and math problem-solving but did not find a difference in processing speed or reading comprehension. The present study also found no differences in walking vs. sitting on reading comprehension. Similar to the present study, Alderman et al.[5] found no differences in reading comprehension between walking and sitting. In the study by Miller et al.,[8], no difference in typing speed was reported between walking and sitting. The current study did not measure typing speed and thus cannot directly compare findings, but typing speed and reading comprehension can be considered essential work productivity tasks. This study found no differences in reading comprehension, a work productivity measure, however walking was associated with less time reading, so a possible improvement of work productivity In contrast, Podrekar et al.[9] used a meta-analysis to evaluate the work performance

and cognitive function during cycling and a treadmill desk. They found that the treadmill workstation significantly reduced typing speed. However, they concluded that work performance while walking on a treadmill was likely not due to decreased cognitive function. However, a systematic review of studies in overweight and obese participants found that a treadmill workstation improved work performance.[10]

One solution to decrease risks for health problems and sedentary behavior is via an active workstation. The present study found significantly higher heart rates and reduced sedentary time walking while reading compared to sitting. Similar to the present study, Torbeyns et al.[6] found overall that active workstations decreased sitting time, increased energy expenditure and positively affected several health markers. A systematic review with overweight and obese participants reported decreased sedentary time and increased physical activity level and energy expenditure among different active workstations (treadmill, cycling, stepping, standing).[10] However, the treadmill workstation was the only active workstation that helped manage body weight. Miller et al.[8] also reported higher caloric expenditure while walking versus sitting.

There were three known study limitations. First, several basketball players who participated in this study were well over six feet tall. The walking treadmill desk was not high enough for them, resulting in some leaning over to see the reading comprehension test and for others to pick up the laptop. This may have negatively affected their reading comprehension. Second, although this study used a crossover design for the initial activity (half of the participants walked first, while the other half sat first), it did not employ a crossover design for the reading comprehension test itself. All participants took the same test while sitting (test 1), and all took the same test while walking (test 2). Thus, the difficulty of the test was assumed to be equal. Although tests 1 and 2 were not evaluated for difficulty, the number of words in each reading comprehension test were very similar (sitting test = 325 vs walking test = 326 words). The third limitation was the absence of a "practice period" for participants walking on the treadmill. Most people have never attempted to read and walk on a treadmill simultaneously, and thus, not providing the participants a "practice period" likely resulted in lower test scores. Thus, a "practice period" would have likely resulted in better test scores since learning curves are typical.

The study had three significant strengths. First, this study looked at reading comprehension for sitting and walking using an accessible online Test Prep Review website. Many people use online resources, and thus, this study attempted to replicate a "real world" atmosphere. Second, this study measured heart rate to confirm that participants were expending more energy while walking than sitting. Although heart rate does not directly measure energy expenditure, heart rate is often used as a surrogate for energy expenditure due to its positive correlation with it. Third, this study included various college participants (i.e., athletes, non-athletes, males, and females). Doing this provides a more diverse view of how walking versus sitting affects reading comprehension.

There are two implications of this study. First, this study found reading comprehension scores similar while walking and sitting. Thus, a person looking to be more physically active without wanting to set "extra" time aside and without a decrease in work productivity may want to consider using an active treadmill workstation. Second, corporations or institutions that house many desk jobs may want to consider active workstations for their employees as a way to improve their employees' health and thus potentially lead to fewer health claims.

In this study, reading comprehension was similar between walking and sitting. However, non-significant differences in reading comprehension were approaching significance ($p = 0.053$), suggesting possible evidence of a slight decline in reading comprehension while walking. As expected, heart rate was significantly lower while sitting versus walking. The total time it took to complete the test was significantly lower while walking than sitting, which was unexpected. Based on this study, adding an active workstation would not significantly affect reading comprehension in the workplace and could potentially decrease time spent reading, and subsequently improve job productivity. While a treadmill workstation is one possible solution to prevent health problems and a sedentary lifestyle, it is recommended that studies be performed in different populations.

Conclusions

Compared to sitting, walking on a treadmill resulted in similar reading comprehension test scores, a significantly higher heart rate, and significantly faster total time to complete the reading comprehension test.

Acknowledgments
The authors would like to thank Huntington University for the use of the Science lab and testing equipment. We would also like to thank our participants for volunteering in this study.

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