Spring 2017

Intervention to Enhance the Use of Sit-Stand Desks in College Students

Ashley Raulli

INTERVENTION TO ENHANCE THE USE OF SIT-STAND DESKS IN COLLEGE STUDENTS

by

Ashley Raulli

A thesis submitted in partial fulfillment of the requirements
for graduation with Honors in the Health and Human Physiology

_____

Lucas Carr
Thesis Mentor

Spring 2017

All requirements for graduation with Honors in the
Health and Human Physiology have been completed.

_____

Gary Pierce
Health and Human Physiology Honors Advisor

INTERVENTION TO ENHANCE THE USE OF SIT-STAND DESKS IN COLLEGE STUDENTS

By: Ashley Raulli

Abstract

The purpose of this study is to test the effect an instructor-led activity break intervention on college students' standing time, sitting time, physical comfort and alertness during class. The participants of this study were recruited from four sections of a course called Writing for Health and Human Physiology (HHP:3900). The class duration is 2.5 hours and is taught by the same instructor. Each student was exposed to two conditions: 1) access to sit-stand desks only; and 2) access to sit-stand desks plus instructor led activity breaks every 30 minutes. Sitting and standing behaviors were measured objectively throughout the class with an ActivPAL activity monitor. Comfort and alertness were measured three times (minute 0, 60, 120) using previously demonstrated scales. No significant changes were observed for sitting time or standing time between the two conditions. Additionally, no between group changes were observed for self-reported discomfort or alertness. However, participants did report they enjoyed the instructor-led activity breaks and would support the use of this type of intervention in future classes.

The null findings are likely due to testing the intervention in a class led by an engaging instructor who encouraged students to move during class on a regular basis. This study needs to be replicated in traditional lecture style classes in which students are asked to sit for extended periods of time.

Introduction

Any activity characterized by an energy expenditure of $\leq$ 1.5 metabolic equivalents within a sitting or reclined position is considered sedentary behavior (Sedentary Behaviour Research Network, 2012). Previous research has shown that prolonged bouts of sedentary behavior can have detrimental effects on an individual's health, such as increased risk of diabetes, cardiovascular disease, some cancers, and all-cause mortality (Healy et al., 2008; Katzmarzyk et al., 2009; Tremblay et al., 2010; Wilmot et al., 2012). However, there may be potential health benefits if prolonged bouts of sedentary behavior are interrupted with even brief bouts of activity. These benefits include a decrease in waist circumference, BMI, triglycerides, 2-hour plasma glucose levels, and risk of developing cardiometabolic diseases (Healy et al., 2008).

There is evidence to suggest introducing sit-stand desks may be an effective approach for breaking up prolonged bouts of sedentary behavior in various populations. One population that is frequently studied to test the effects of sit-stand desk interventions is sedentary office workers. A recent Cochrane review concluded introducing sit-stand desks to sedentary work setting has been shown to decrease worker's total sitting time between 30 minutes and 2 hours per day (Shrestha et al., 2016). Furthermore, in a recent observational study conducted by our group, long-term users of seated desks were found to stand one hour more and sit one hour less per workday when compared to long-term users of sit-stand desks (Carr et al, 2016). It has also been reported that call center workers with sit-stand desks are 45 percent more productive than those who have seated desks only (Garrett et al., 2016).

Another population that has had success with sit-stand desk interventions is K-12 students. In a recent study conducted in the school setting, students who used sit-stand desks

stood 45 minutes more than students who used seated desks (Clemes et al., 2015). Studies have also reported numerous benefits for K-12 students who have been provided access to sit-stand desks in their classrooms. Some of these benefits include increased caloric expenditure (Benden et al., 2011; Rieff et al. 2012) and increased engagement during class (Dornhecker et al., 2015). Another benefit of sit-stand desks is the feasibility of implementing them within K-12 classrooms and the "flexibility of learning" it provides for teachers and students (Koepp et al., 2012; Hinckson et al., 2013).

While college level courses are organized differently than K-12 classes, there is reason to suspect sit-stand desks might also be useful for reducing classroom sitting time of college students. Further, evidence suggest college students might be at risk for sedentary related diseases. A study conducted by Buckworth and Nigg (2004) found that college students spend as much as 30 hours per week sedentary, not including time spent sitting in class. Another study by Conroy and colleagues (2013) found that more than 70 percent of college students reported sitting more than six hours per day. In addition, approximately 45 percent of college students are physically inactive (Keating et al., 2005) and most students tend to become less active as they progress throughout college, and even after graduation (Sparling & Snow, 2002). Collectively, these findings suggest college students may be a population at-risk for inactivity and an ideal population for interventions. Based on previous success implementing sit-stand desks in both office spaces and K-12 classrooms, one could assume implementing sit-stand desks within a college classroom would show similar results and benefits. However, sit-stand desks have not yet been tested in college classrooms.

In an effort to determine the acceptability and feasibility of introducing sit-stand desks into college classrooms, Benzo and colleagues (2016) conducted a study with 993 college

students and 149 instructors. Participants were asked to complete a survey to assess their perceptions and attitudes towards introducing sit-stand desks in college classrooms. The study found 76 percent of students and 86 percent of instructors favored the idea of introducing sit-stand desks in college classrooms; and more than half of students and instructors felt health, attention, and restlessness would improve during class if these desks were available within the classroom. Collectively, these findings support the acceptability of introducing standing desks in college classrooms.

Based on the positive feedback received from college students and instructors, Jerome et al. (2016), conducted an intervention to test the efficacy of replacing seated desks with sit-stand desks in college classrooms on student's standing and sitting behaviors during class. The results showed students stood roughly 10 percent more while attending class with sit-stand desks compared to attending class with seated desks. A secondary aim of this study was to identify the top barriers that prevented students from standing during class as well as the facilitators that would possibly promote more standing and sit-stand transitions during class. Student's reported "standing felt awkward" and "they did not want to be a distraction" as barriers to standing during class. Students reported "seeing other students standing" and "receiving reminders/encouragement by the instructor to stand" as the top facilitators to promote more standing during class. These findings support future interventions aimed at addressing several of the social norms barriers to standing and approaches that are facilitated by the instructor.

There is also evidence to support examining the impact of interrupting classroom sitting on other health outcomes that go beyond energy balance and cardiometabolic risk factors. A study by Hosteng and colleagues (2017) explored the impact of prolonged classroom sitting on college student's self-reported levels of physical discomfort and alertness throughout a 2.5-hour

lecture class. Students were asked to remain seated during the 2.5 hours class and to complete the Stanford Sleepiness Scale and the General Comfort Scale every 15 minutes. The results showed that student alertness significantly declined after 30 minutes of sitting and that students reported being uncomfortable after 88 minutes of sitting. This study supports future interventions that encourage students to stand up and take a break from sitting at least every 30 minutes.

The primary purpose of the proposed study is to determine the effect of instructor-led standing breaks on student standing time, student sitting time, and number of sit-to-stand transitions, physical discomfort and alertness during class. We hypothesize that instructor-led standing breaks will increase standing time and number of sit-to-stand transitions while decreasing sitting time. In addition, we hypothesize that instructor-led standing breaks will prevent impairment in physical discomfort and alertness.

Methods

Participants

The participants of this study were recruited from four sections of a course called Writing for Health and Human Physiology (HHP:3900). Each class was 2.5 hours long and was taught by the same instructor and in the same classroom. The classroom used in this study had 20 sit-stand desks that were accompanied by stools that gave students the option to sit or stand during

class. Each section had 20 students enrolled at the beginning of the spring semester for a total of 80 possible participants.

Design

During the first week of the study, all participants were given a brief presentation about the study and were given the opportunity to enroll. Students had the option to not participate without any penalty to them. Students who decided to enroll were given an envelope at the beginning of each class during the second and third week that contained an ActivPal activity monitor (Figure 1), tape to attach the activity monitor to their leg, and a paper packet consisting of three different surveys. The ActivPal activity monitors were taped onto each participant's leg halfway between their hip and knee. Total standing time (minutes), sit-to-stand transitions (number), stand-to-sit transitions (number) steps, and energy expenditure (METs) were recorded throughout the duration of class. The survey packets contained a demographics survey, the Standard Sleepiness Scale, the General Comfort Scale, and a process evaluation survey asking about student engagement during that class period. During week 3, the survey also included an additional process evaluation survey asking the participants' opinions of the instructor-led activity breaks.

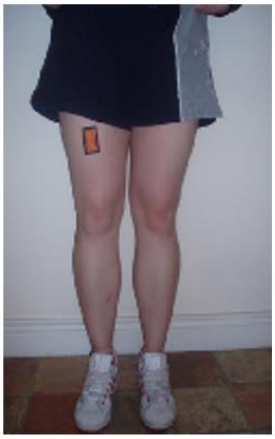

Figure 1. ActivPAL monitor

Figure 2. Study design and time line.

	Week 1	Week 2	Week 3
Section 1 N=20	Introduce study and recruit participants	Standing Desk only	Standing Desk + Instructor breaks
Section 2 N=20		Standing Desk only	Standing Desk + Instructor breaks
Section 3 N=20		Standing Desk only	Standing Desk + Instructor breaks
Section 4 N=20		Standing Desk only	Standing Desk + Instructor breaks

Sit-stand Desks

In the Fall of 2016, our team introduced 25 sit-stand desks into Field House room 332 (see Figure 2). The desks are easily height adjustable for people of different heights and are paired with a bar height stool to allow for sitting during class. Students had the option to sit or stand at their leisure while having access to these desks.

Figure 3. Sit-stand desks

Measures

The primary aim of this study was to determine the effectiveness of the instructor-led standing breaks on standing time and number of transitions per student per class. We hypothesized instructor-led standing breaks would increase standing time and the number of sit-stand transitions. Each student's total standing time and number of sit-stand transitions were

recorded objectively with ActivPal activity monitors. The ActivPAL monitor has been demonstrated as a highly accurate and reliable measure of sitting and standing time in a previous study by An and colleagues (2017).

The secondary aim of this study was to determine the effectiveness of this intervention on physical discomfort and alertness. To measure discomfort, students completed the General Comfort Scale (0-10). To measure alertness, students completed the Stanford Sleepiness Scale (1-8). The Standard Sleepiness Scale has a range from 1-8; 1 meaning they "feel active, vital, alert, or wide wake", and 8 meaning "they are asleep." If students report a score of 3 (Awake, but relaxed; responsive, but not fully alert), then they have reached a threshold that indicates alertness has significantly declined. The General Comfort Scale has a range from 0-10; 0 meaning, "I feel completely relaxed" and 10 meaning "I feel unbearable pain." Just like the Stanford Sleepiness Scale, if student report a score of 4 (I feel uncomfortable) this is a threshold that indicates a student has transitioned from comfortable to uncomfortable. Students completed each scale at the beginning of class, one hour into class, and two hours into class to determine if each measure changed over the course of the class and also to compare the post-class measure between the two conditions. The students also completed a process evaluation survey at the end of class during week 3 to provide feedback on the instructor-led activity breaks.

Statistical Analysis

We first conducted a univariate analysis to check the distribution, central tendency and dispersion of the sitting, standing and sit-stand transition data. We used paired sample t tests to make between group comparisons for our primary and secondary outcomes. For aim 1 we compared (week 2 vs. week 3) the average time spent standing during class per student and the

average number of sit-stand transitions per student. For aim 2, we compared the average perceived discomfort scores at minute 120 and average perceived alertness scores at minute 120. We also examined changes in scores of discomfort and alertness over the duration of each class (time points 1, 2 and 3) suing a one-way ANOVA test. The process evaluation data was analyzed using descriptive statistics. All statistical analyses was conducted using SPSS version 22. Statistical significance was set at $P < 0.05$.

Results

A total of 50 undergraduate college students participated and completed the study. Participant's mean age was 21.3 years old with 58% of this population being female (N=29) and 42% male (N=21). Most students reported being White (84%, N=42), Asian (8%, N=4), or Black/African American (6%, N=3). The majority of the participants identified as Not Hispanic or Latino (94%, N=47). Participants reported sitting 64% and 71% of the day prior to class on the days of data collection during weeks 2 and 3, respectively.

Table 1. Participant Demographics (N=50)

	Mean(SD) or %
% Female	58%
% White	84%
Age (years)	21.3 (2.6)
% Not Hispanic or Latino	94%
%Sitting time throughout the day – Week 2	64.4%
%Sitting time throughout the day - Week 3	71.2%

The primary outcome of this study was to determine if this intervention would have an effect on percent sitting time, percent standing time and/or total number of sit-to-stand transitions

(Table 2). No significant between group differences (week 2 vs. week 3) were observed for percent class time spent standing, percent class time spent sitting, and average number of sit-to-stand transitions (Table 2).

Table 2. Comparison of percent sitting time, percent standing time, total sit/stand transitions and (N=34).

	Week	**Mean**	**SD**	**P-value Wk 2 vs Wk 3**
Percent Class Spent Sitting or Lying (%)	2	63.1	26.4	0.22
	3	70.8	25.4	
Percent Class Spent Standing (%)	2	34.9	25.6	0.20
	3	27.2	24.2	
Total sit/stand movements	2	5.2	4.6	0.57
	3	6.0	6.3	

Additionally, no significant between group differences (week 2 vs. week 3) were observed for student's perceived discomfort or alertness (Table 3). Neither discomfort nor alertness changed over the duration of the class during weeks 2 and 3 (Table 3).

Table 3. General Comfort Scale scores at week 2 and 3 (N=46).

Time point		**Week 2**	**Week 3**
1	Mean	2.6	2.5
	Std. Deviation	1.6	1.0
2	Mean	2.7	2.5
	Std. Deviation	1.3	1.0
3	Mean	2.5	2.9
	Std. Deviation	1.4	1.53
	P-value (Time 1, 2, 3)	0.91	0.30
	P-value (Week 2 vs Week 3)	NA	0.72

Table 4. Stanford Alertness Scores for week 2 and 3 (N=46)

Time point		**Week 2**	**Week 3**
1	Mean	2.9	2.8
	Std. Deviation	0.9	1.1
2	Mean	2.6	2.7
	Std. Deviation	0.7	1.0
3	Mean	2.5	2.8
	Std. Deviation	1.0	1.2
	P-value (Time 1, 2, 3)	0.08	0.83
	P-value (Week 2 vs Week 3)	NA	0.14

When examining the process evaluation survey data collected at the end of class during week 3, students reported an average score of 3.6 for how the instructor-led activity breaks helped them perform better in class, which is between a score of Neutral and Agree. The students also reported an average score of 3.9 for the question asking about how the instructor-led activity breaks encouraged me to stand more in class, which is closer to the Agree category than the Neutral category. Participants reported that they disagreed with the statement that instructor-led activity breaks were disruptive to the class based on their average reported score of 2.2. Finally, students reported an average score of 3.8 when asked if they support adding instructor led standing breaks to other classes on campus, which is closer to the category of Agree than it is closer to Neutral.

Table 5. Process Evaluation data collected during week 3 (N=50).

	Likert Scale (1=Strongly Disagree; 5=Strongly Agree)	
	Mean	**SD**
The instructor led activity breaks helped me perform better in class.	3.6	1.7
The instructor led activity breaks encouraged me to stand more in class.	3.9	0.8
The instructor led activity breaks were disruptive to the class.	2.3	0.9
I support adding instructor led standing breaks to other classes on campus.	3.8	0.9

Discussion

For our primary outcome, we tested the effects of instructor-led activity breaks on sitting time, standing time and sit-to-stand transitions. However, we found no differences in sitting time, standing time or sit-stand transitions suggesting this intervention did not have its intended effect. The reasons for the null findings are likely due to testing the intervention in a class that naturally encourages students to move frequently throughout the class. In order to observe an effect for this intervention, it would be important to test this approach in a class that does not include as much movement. Traditional lectures, for example, often require students to sit for long periods of time and would likely be a better setting for future studies.

The secondary aim of this study was to test the effect of instructor-led activity breaks on self-reported comfort and alertness. Our prediction was that the instructor-led activity breaks would help prevent impairments in comfort and alertness that were observed with continuous sitting in a previous study led by Hosteng and colleagues (2017). However, neither comfort nor alertness was impaired in weeks 2 or 3 of this study. The lack of change in these outcomes over

the course of the class is likely due to the unexpected high amounts of movement that students were engaging in during these classes. Again, we would expect this outcome to be different if this study were replicated in a less active class.

The process evaluation data collected suggests students generally liked the instructor-led activity breaks, supported the idea of implementing them in other classes, and did not feel that the breaks disrupted the overall structure of the class. The students also reported that these standing breaks encouraged them to stand more in class then they normally would. These results suggest that implementing this type of intervention into classroom would not hurt the students in any way, and hopefully encourage a more active classroom.

If the study were to be replicated, there would need to be changes in the design in order to take into account factors that were not originally considered. A primary reason for the null findings in this study was due to the lack of control we had over how the instructor delivered this class. Students were very engaged and moved a lot during this discussion style class. This is a different design than the traditional lecture style class in which students sit the majority of class time. In a previous study by Hosteng and colleagues (2017), physical discomfort increased significantly and alertness declined over a 90-minute lecture in which college student participants sat the entire class period. Students reached critical thresholds for alertness after 30 minutes of sitting and discomfort after 88 minutes of sitting. In the present study, students never approached these thresholds, which is likely due to how active they were during class. Future studies should be conducted in classes that are more sedentary such as large lecture based classes.

The majority of lecture halls have seated desks, and it would be expensive to replace seated desks in these types of classrooms with sit-stand desks. However, sit-stand desks may not

be necessary to implement instructor-led activity breaks into a college classes. There is a need to determine the minimum amount of movement necessary to prevent impairments in physical discomfort and alertness that have been observed with prolonged sitting. It is possible that even small brief movements such as standing up or moving into small groups could be enough to prevent these impairments from occurring. However, future studies are needed to confirm this.

References

An, H. S., Y. Kim, and J. M. Lee. "Accuracy of Inclinometer Functions of the ActivPAL and ActiGraph GT3X+: A Focus on Physical Activity." *Gait & Posture.* U.S. National Library of Medicine, Jan. 2017. Web. 02 May 2017.

Benzo, R.M., Gremaud, A.L., Jerome, M. and Carr, LJ. Learning to Stand: The Acceptability and Feasibility of Introducing Standing Desks into College Classrooms. Int J Environ Res Public Health. 2016 Aug 15;13(8).

Benden, M.E., Blake, J.J., Wendel, M.L., Huber, J.C. (2011). The impact of stand-biased desks in classrooms on calorie expenditure in children. *American Journal of Public Health*, 101(8), 1433-1436. doi: 10.2105/AJPH.2010.300072.

Buckworth, J. & Nigg, C. (2004). Physical Activity, Exercise, and Sedentary Behavior in College Students. *Journal of American College Health*, 53(1), 28-34.

Carr, LJ., Swift, M, Ferrer, A., and Benzo, R. Cross-sectional Examination of Long-term Access to Sit-Stand Desks in a Professional Office Setting. Am J Prev Med., 2016 Jan;50(1):96-100.

Clemes, S.A., Barber, S.E., Bingham, D.D. (2015). Reducing children's classroom sitting time using sit-to-stand desks: findings from pilot studies in UK and Australian primary schools. *Journal of Public Health (Oxf)*.

Conroy, D.E., Maher, J.P., Elavsky, S., Hyde, A.L., Doerksen, S.E. (2013). Sedentary Behavior as a Daily Process Regulated by Habits and Intentions. *Health Psychology*, 32(11), 1149-1157. doi: 10.1037/a0031629.

Dornhecker, M., Blake, J., Benden, M., Zhao, H., Wendel, M. (2015). The Effect of Stand-biased Desks on Academic Engagement: An Exploratory Study. *International Journal of Health Promotion and Education*, 53(5), 271-280.

Garrett, G., Benden, M., Mehta, R., et al. (2016). Call Center Productivity Over 6 Months Following a Standing Desk Intervention. *IIE Transactions on Occupational Ergonomics and Human Factors*. doi:10.1080/21577323.2016.1183534.

Healy, G.N., Dunstan, D.W., Salmon, J., et al. (2008). Television time and continuous metabolic risk in physically active adults. *Medicine & Science in Sports & Exercise*, 40(4), 639-645. doi: 10.1249/MSS.0b013e3181607421.

Healy, G.N., Dunstan, D.W., Salmon, J., et al. (2008). Breaks in sedentary time: beneficial associations with metabolic risk. *Diabetes Care*, 31(4), 661-666. doi: 10.2337/dc07-2046.

Henson, J., Yates, T., Biddle, S.J., et al. (2013). Associations of objectively measured sedentary behaviour and physical activity with markers of cardiometabolic health. *Diabetologia*, 56(5), 1012-1020. doi: 10.1007/s00125-013-2845-9.

Hinckson, E.A., Aminian, S., Ikeda, E. (2013). Acceptability of standing workstations in elementary schools: A pilot study. *Preventive Medicine*, 56(1), 82-85.

Hosteng, K, Benzo, R, Phillips, A. and Carr, LJ. 2016 Impact of prolonged classroom sitting on physical discomfort and alertness in college students. Unpublished manuscript.

Jerome, M, Raulli, A.K., Gremaud, AG, Benzo, R, Hosteng, K, and Carr, LJ. (2016) Higher Education: Testing the Efficacy of Height Adjustable Sit-Stand Desks in College Classrooms. Unpublished manuscript.

Katzmarzyk, P.T., Church, T.S., Craig, C.L., Bouchard, C. (2009). Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Medicine and Science in Sports and Exercise*, 41(5), 998-1005. doi: 10.1249/MSS.0b013e3181930355.

Keating, X.D., Guan, J., Pinero, J.C., Bridges, D.M. (2005). A meta-analysis of college students' physical activity behaviors. *Journal of American College Health*, 54(2), 116-125.

Koepp, G.A., Snedden, B.J., Flynn L. (2012). Feasibility Analysis of Standing Desks for Sixth Graders. *Childhood Obesity and Nutrition*, 4(2), 89-92. doi: 10.1177/1941406412439414.

Reiff, C., Marlatt, K., Dengel, D.R. (2012). Difference in caloric expenditure in sitting versus standing desks. *Journal of Physical Activity and Health*, 9(7), 1009-1011.

Shrestha, N., Kukkonen-Harjula, K.T., Verbeek, J.H., et al. (2016). Workplace interventions for reducing sitting at work. *Cochrane Database Systematic Review*. doi: 10.1002/14651858.CD010912.pub3.

Sedentary Behaviour Research Network. 2012. Standardized use of the terms "sedentary" and "sedentary behaviours". *Applied Physiology, Nutrition, and Metabolism*. 37, 540–542.

Sparling, P.B. & Snow, T.K. (2002) Physical Activity Patterns in Recent College Alumni. *Research Quarterly for Exercise and Sport*, 73(2), 200-205, doi: 10.1080/02701367.2002.10609009.

Tremblay, M.S., Colley, R.C., Saunders, T.J., Healy, G.N., Owen, N. (2010). Physiological and health implications of a sedentary lifestyle. *Applied Physiology, Nutrition, and Metabolism*, 35(6), 725-740. doi: 10.1139/H10-079.

Wilmot, E.G., Edwardson, C.L., Achana, F.A., et al. (2012). Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis. *Diabetologia*, 55(11), 2895-2905. doi: 10.1007/s00125-012-2677-z.