Health Risks Involved with Prolonged Sitting: Spreading Awareness to College Students

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Health Risks Involved with Prolonged Sitting

Spreading Awareness to College Students

By
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An Honors Thesis Submitted in Partial Fulfillment of the Requirements for Graduation from the Western Oregon University Honors Program

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Abstract

This thesis is about the health risks involved with prolonged sitting. Our bodies are designed to move, and research has shown that sedentary lifestyles increase health risks. In addition to type 2 diabetes, cancers, and cardiovascular diseases, sedentary lifestyles can lead to premature mortality. Often times a sedentary activity such as prolonged sitting is overlooked, when in fact, sitting for long periods of time has a negative effect on health. The goal of this thesis is to research and spread awareness about the health risks involved with prolonged sitting to the students of Western Oregon University. In order to spread awareness, I have created and displayed posters supported by flyers throughout campus with information from my research on the topic. The posters address sedentary lifestyles as a problem and display what a sedentary lifestyle looks like. The flyers discuss the problem of prolonged sitting and potential solutions. Although there are posters and resources that already exist on the topic of sedentary lifestyles, I have created resources specific to the college student population in order to be more effective in spreading awareness to them. This is a widespread problem with serious consequences, yet simple fixes. This is an attempt to spread awareness to a population that includes individuals at a critical point in life who may not be informed about this issue.
Introduction

Purpose of Thesis

The purpose of this thesis is to improve the overall quality of life of the college students at Western Oregon University through addressing an unexpected threat to health.

Research Questions

- What is sedentary behavior?
- How is sedentary behavior related to prolonged sitting?
- What are the health risks involved with prolonged sitting?
- What is the physiology behind the health risks involved with prolonged sitting?
- Why is it important to spread awareness about the dangers of prolonged sitting to college students?
- How can this information be shared with the college student population in an effective manner?

Objectives for Thesis

The objective for this thesis is to spread awareness about the health risks involved in prolonged sitting to college students on the Western Oregon University campus. Overall, I hope that college students will become informed and mindful when it comes to sitting. An ideal impact would involve students taking action to reduce their risk for chronic diseases by taking action on their sitting times.
Organization of Thesis

The first section of this thesis discusses sedentary behavior and how it is related to long periods of sitting. The second section is a literature review of the research that I’ve done on the topic of prolonged sitting with some information specific to sitting in college students. The third section of this thesis explains the process of spreading awareness throughout the campus.
Literature Review

Section 1. Sedentary Behavior

Introduction to Sedentary Behavior

What are the definitions of activity terminology?

The definition of physical activity is any movement that is carried out by skeletal muscles that requires energy (Gummelt, 2015). The definition of exercise is planned, structured, repetitive, and intentional movement intended to improve or maintain physical fitness (Gummelt, 2015). Physical fitness consists of five components; cardiorespiratory fitness, muscular strength fitness, muscular endurance fitness, flexibility fitness, and body composition (Gummelt, 2015). Therefore exercise falls within the classification of physical activity, but physical activity also includes movements that wouldn’t fall into the category of exercise (Gummelt, 2015). The definition of physical inactivity is lack of physical activity, therefore it is the absence of movement (WHO, 2017). The definition of sedentary behavior is long periods of physical inactivity. Therefore sitting, which is defined as continuous periods of being seated would fall into the categories of physical inactivity and sedentary behavior when done for long periods of time.

It is important that the definitions of activity terminology are clarified because there are many different understandings and perceptions of what terms like physical activity vs. physical inactivity actually mean. For instance, The American College of Sports Medicine (ACSM) states that individuals are categorized to be physically active if
they have engaged in 30 minutes of moderate intensity exercise, on at least three days per week, for the past three months. While those 30 minutes of exercise are essential and beneficial for health, it is important to remember to consider the activities done throughout the rest of the day. This can be done by looking at how many waking hours are spent in physical activity vs. physical inactivity. If an individual engages in 30 minutes of exercise, but has a job that requires them to be sedentary for most of the day, the ACSM would categorize the individual to be physically active despite the fact that most of the individual’s day was spent being inactive. In this case, and many others, the exercise is important, but the time spent sedentary should not be overlooked.

Our bodies are made to move and that is why physical activity is important. It is unrealistic to eliminate physical inactivity completely, but inactivity becomes a concern when it turns into sedentary behavior. Sedentary behavior includes sitting during commuting, while working, in the home, and as a part of leisure time (Owen, Healy, Matthews, & Dunstan, 2010). In physiological terms, sedentary behavior is defined to be any behavior during waking hours that requires an energy expenditure of less than 1.5 METs, which are multiples of the basal metabolic rate (Ainsworth et al., 2000). To put this into perspective, brisk walking expends energy worth 3-4 METs and running expends energy worth 8-9 METs (Ainsworth et al., 2000). Therefore, activities such as watching television or working at a desk can be determined to be sedentary behavior due to the low energy expenditure involved in those activities. Prolonged sitting is the main source of sedentary behavior that people encounter and fortunately it is a behavior that can be modified.
**Why is prolonged sitting so common?**

Simply put, prolonged sitting is ubiquitous. Since the middle of the last century, physical, economic and social environments have been quickly changing (Owen, et al., 2010). These changes in society have led to lifestyles that involve significant reductions in the demands for physical activity and therefore, energy expenditure (Thorp, Owen, Neuhaus & Dunstan, 2011). In homes, workplaces, schools, modes of transportation, and recreational venues, there are always opportunities and in many cases, requirements to sit (Dunstan, Howard, Healy, & Owen, 2012). Furthermore, jobs have evolved to involve more and more sitting time. In 1970, two in ten working Americans had jobs that required only light activity (predominantly desk job), whereas in 2000, more than four in ten working Americans were in light activity jobs (Owen, Sparling, Healy, Dunstan, & Matthews, 2010). Developments such as televisions, computers, cell phones, and video games have also created unlimited opportunities for people of all ages to sit for long periods of time. Over the past 20 years, total screen time has increased dramatically, as computers, phones, and televisions have become a part of everyday life for people of all ages (Owen, et al., 2010). Developments and improvements in technology have decreased the demand for physical activity, but ultimately it is the responsibility of people for letting sedentary behaviors become lifestyles.

Prolonged sitting is also common because of the lack of clarity within the definitions of the terminology of activity. When it comes to spreading awareness about
overall health, exercise is often a major focus. However, as mentioned before, the types of activity or lack thereof that are done throughout the rest of the day is just as important as the time spent in exercise. In other words, too much sitting is distinct from too little exercise (Owen, et al., 2010). Although both too much sitting and too little exercise have negative effects on health, it is easy to overlook the seemingly harmless act of sitting even though it can be detrimental to health independent of exercise. In fact, even the individuals who exceed public health exercise recommendations compromise their metabolic health by sitting for long periods of time (Owen, et al., 2010). To further explain this, the “Active Couch Potato” phenomenon was created to describe the potential for excessive sitting time and being physically active to co-exist (Owen, et al., 2010). Prolonged sitting involves a unique set of behaviors and unique consequences that are independent of those involved in the absence of moderate to vigorous physical activity (Owen, et al., 2010). Therefore, awareness of sitting time, awareness of the health risks involved with prolonged sitting, and the lack of understanding on the differences between too much sitting and too little exercise act as significant contributions to the problem.

Effect of Sedentary Lifestyles on Health

*What are the health risks associated with sedentary lifestyles?*

According to the US National Health and Nutrition Examination Survey (2003-2004, 2005-2006), the majority of adults surveyed spent waking time in sedentary behavior (58%) or light-intensity activity (39%) and only 3% in exercise time. The popularity of sedentary behavior is concerning because sedentary lifestyles are
associated with an increased risk for more than 35 chronic diseases/conditions and increased mortality rates (Thyfault, Du, Kraus, Levine, & Booth, 2015). The body is made to move, and thus, not moving will pose negative effects throughout all the systems of the body. Data collected from many studies show that inactivity and low levels of activity are associated with increased risk for cardiovascular diseases, obesity, type 2 diabetes, cancer, and increased mortality risk (Engeroff, Fuzeki, Vogt, & Banzer, 2016).

Figure 1. This diagram displays the different body systems that physical inactivity can have an effect on and the specific conditions or diseases within each body system that are associated with physical inactivity (Booth, Roberts, Thyfault, Ruegsegger & Toedebusch, 2017)
Mason and colleagues (2004) suggest that sedentary lifestyles are responsible for a large amount of chronic diseases, impaired physical function, lowered quality of life, more than 300,000 premature deaths, and more than $90 billion in health care costs per year in the United States. Research by Carlson and colleagues (2014), have shown that 11.1% of health care spending in the U.S. from 2006-2011 were associated with sedentary lifestyles. This calculates to be approximately $131 billion as the cost for sedentary lifestyles. Using the percentage from previous years, an estimate of $333 billion of the $3 trillion total U.S. health care costs in 2014 can be calculated to account for sedentary lifestyles (Booth, Roberts, Thyfault, Ruegsegger, Toedebusch, 2017). Significant amounts of money are being used for treatment of diseases that result from being sedentary and the amount will only continue to grow if the issue of sedentary lifestyles isn’t addressed.

Unlike many of the conditions and diseases that currently have no cure, the issue of sedentary lifestyles and its contribution to related diseases is something that can only be controlled by each individual. While other health problems have complicated solutions that need to be left to the scientists, this epidemic is something that needs to be addressed and acted upon by people. The cure for this problem is the change in the way that lives are lived. As mentioned earlier, the issue is that lifestyles have changed to involve less movement and more sitting (Owen et al., 2010). Addressing this issue can prevent disease and illness, premature death, loss of large amounts of money that could be spent towards solving health problems that are beyond the control of people.
Relationship Between Sedentary Lifestyles and Sitting

The term sedentary was derived from the Latin term “sedere” which means “to sit” (Dabundo, Sidman, & Fiala, 2015). While sedentary behaviors can describe a variety of activities for different purposes and in different contexts, time spent sitting is the overall representation of what sedentary behavior primarily involves (Dabundo et al., 2015). In other words, sitting time is the main contributor to sedentary behaviors.

Attempting to make changes to one’s lifestyle can be intimidating. However, an easier way to look at it is to think about the amount of time spent sitting each day. While sedentary behaviors are “different activities, for different purposes in different contexts”, sitting time is a “generic descriptor covering what these sedentary behaviors primarily involve” (Owen et al., 2010, pg. 2). The many periods of sitting that we engage in each day is what actually makes up our sedentary lifestyles and it seems a little less intimidating to think about adjusting the time we spend sitting as opposed to our lifestyles.

Section 2. Sitting Behavior

Effect of Prolonged Sitting on Health

Prolonged sitting is associated with many health risks such as obesity, type 2 diabetes, vitamin deficiencies, hypercholesterolemia, muscle/skin changes, cardiovascular conditions, and cancer (Booth et al., 2017). Obesity is a worldwide health problem that affects over 100 million people (Inyang & Stella, 2015). Spending long
periods of time sitting leads to the accumulation of excess calories which is essentially weight gain, and eventually obesity if the individual’s caloric intake is greater than their calories expended (Inyang & Stella, 2015). The total cost in America of the effects of obesity, including income lost from decreased productivity and hospitalization, and premature mortality were approximately 147 billion dollars in 2008 (WHO, 2018). Some of the other conditions associated with obesity include hypertension, diabetes, cancer, and osteoarthritis (Inyang & Stella, 2015).

Type 2 diabetes, also known as non-insulin dependent diabetes, is a result of the body’s inability to utilize insulin effectively (Inyang & Stella, 2015). Prolonged sitting behaviors are strongly associated with increased eating, weight gain, and increased screen time, all of which are major risk factors for type 2 diabetes (Brannon & Feist, 2007). Research has shown that nine out of ten cases of type 2 diabetes could have been prevented if risk factors of weight, diet, smoking, and inactivity were addressed (Inyang & Stella, 2015). However, research has also shown that the absence of exercise is not what lead individuals to diabetes, but rather, the amount of time spent sitting that can increase the risk (Inyang & Stella, 2015).

**Physiology of Prolonged Sitting**

Research has shown that sedentary behavior has a direct effect on vascular health, metabolism, and bone mineral content, all of which contribute to chronic diseases (Tremblay, Colley, Saunders, Healy, & Owen, 2010). While physical inactivity has long been viewed as a minor risk factor for chronic diseases, a systematic review of
literature on the relationship between physical activity and prevention of coronary heart disease (CHD) has shown that physical inactivity is in fact a strong independent risk factor for CHD (Powell, Thompson, Caspersen & Kendrick, 1987). According to the American Heart Association (AHA, 1992), physical activity improved glucose tolerance, increased fibrinolysis (breaking of clots), and reducing blood pressure; all of which play a role in metabolic health. Of equal importance, long periods of sitting can cause a reduction in bone mineral density which can lead to negative health outcomes (Tremblay et al., 2010).

**What are the effects on cardiovascular health?**

While environmental and genetic factors contribute to an individual’s risk for CHD, behavioral factors such as physical inactivity are aspects of life that individuals have control over. The American Heart Association (1992) Researchers calculated risk of coronary heart disease (CHD) due to inactivity to be a greater risk than those who have high cholesterol and those who smoke cigarettes (AHA, 1992). However, it is similar to the risk ratio for hypertension (high blood pressure), which is related to metabolic health risks. Sedentary individuals have about twice the chance of experiencing CHD than physically active individual (Powers & Howley, 2012, p. 318).

CHD is associated with atherosclerosis, which is a gradual narrowing of arteries serving the heart due to thickening of the inner lining of the artery by fatty plaque (Powers & Howley, 2012, p. 319). Physical inactivity is one of the behavioral risk factors that interact with other risk factors to cause atherosclerosis (Powers & Howley, 2012, p. 318). Atherosclerosis is the leading contributor to heart attack and stroke deaths (AHA,
1992). It is the narrowing of the artery that will result in reduction of blood flow to the heart therefore leading to a heart attack (Powers & Howley, 2012). It has been thought that the danger of atherosclerosis is occlusion, however, most heart attacks and strokes result from rupture of the plaque which then block blood flow, a process referred to as “inflammation” (Libby, Okamoto, Rocha, & Folco, 2010).

Inflammation is linked to several chronic diseases such as hypertension, coronary heart disease, stroke, cancers, respiratory conditions, type 2 diabetes and the metabolic syndrome (Mathur & Pedersen, 2008). Inflammation is described to be a significant increase in inflammatory cytokines (Powers & Howley, 2012, p. 321). When there is too much adipose tissue present in the body, there are more hormones and inflammatory cytokines released by the adipose tissue (Gustafson, 2010). Increased inflammatory cytokines circulate and interfere with insulin, which is described to be insulin resistance (Gustafson, 2010). Insulin resistance is a reduced ability to take up glucose at a given insulin concentration and is linked to type 2 diabetes and metabolic syndrome in addition to CHD (Powers & Howley, 2012, p. 322).

Furthermore, increased levels of physical activity are associated with decreased levels of inflammation (Powers & Howley, 2012, p. 322). As muscles are used in physical activity, they produce the same types of inflammatory cytokines that lead to inflammation and it can be significantly increased as a result of physical activity (Brandt & Pedersen, 2010). This physical activity induced reduction of inflammation however, involves a different process than that which causes inflammation (Brandt & Pedersen, 2010). The cytokinase, IL-6 can act both as an inflammatory and anti-inflammatory
depending on the circumstances (Brandt & Pedersen, 2010). Therefore, as a result of physical activity, IL-6 works to inhibit the effect of some inflammatory cytokines and increases the concentration of anti-inflammatory cytokines (Powers & Howley, 2012, p. 322). Thus, physical activity helps to reduce inflammation that can lead to chronic diseases including coronary heart disease.

*What are the effects on metabolic health?*

Some aspects of vascular health relate directly to metabolic health and how it is affected by physical inactivity. It was mentioned that hypertension has a strong risk ratio with inactivity, similar to the risk for CHD (Powers & Howley, 2012, p. 318). Hypertension is extremely common, affecting more than 68 million Americans (Gillespie, Kuklina, Briss, & Hong, 2011). It has been found that hypertension tends to occur alongside of metabolic abnormalities - obesity, insulin resistance, and dyslipidemia (elevated triglyceride levels) (Powers & Howley, 2012, p. 322). The coexistence of the conditions are referred to as metabolic syndrome or the deadly quartet if obesity is present (Powers & Howley, 2012, p. 322).

Insulin is a hormone that aids with the uptake of glucose, in other words, the body’s ability to use glucose (Powers & Howley, 2012, p. 322). Because insulin resistance reduces the ability for the body to utilize glucose, blood glucose concentrations increase when insulin resistance occurs. When there are increased blood glucose concentrations, the pancreas secretes more insulin in the attempt to maintain homeostasis (Powers & Howley, 2012, p. 323). However, if the pancreas cannot keep up with the increasing demand for insulin, the blood glucose concentration remains higher than normal, which
is the characteristic of type 2 diabetes (Powers & Howley, 2012, p. 323). Furthermore, individuals with insulin resistance tend to have greater free fatty acid (FFA) levels which can lead to increased plasma triglycerides (Powers & Howley, 2012).

Elevated triglyceride/FFA levels are associated with low levels of lipoprotein lipase (LPL) because LPL is a rate limiting enzyme that regulates the uptake of circulating free fatty acids into adipose tissue and skeletal muscle (Hamburg et al., 2007). Research has shown that acute and chronic sedentary behavior causes a reduce in LPL activity (Hamburg et al., 2007). There is a strong inverse relationship between LPL activity and risk for coronary heart disease (Hamilton, Hamilton, & Zderic, 2004). Therefore, decreased levels of LPL activity are linked to increased risk for cardiovascular disease, increased circulating triglyceride levels, and decreased high-density lipoprotein cholesterol (HDL) cholesterol - all of which may contribute to risks that have been frequently observed to occur during metabolic diseases such as obesity, type 2 diabetes, and coronary heart disease (Hamilton et al., 2004). It has been found that even fragmentary reductions in LPL activity were associated with increased risk for mortality and coronary heart disease (Hamilton et al., 2004).

In a study evaluating the effects of sedentary behavior in rats on LPL activity, Bey and Hamilton (2003) found that skeletal muscle was reduced by >25% after six hours of inactivity, >50% after 12 hours of inactivity, and >75% after 18 hours of inactivity. However, they also found that it took just four hours of light-intensity activity revert to baseline LPL levels (same as previous). In a similar study done on humans, Yanagibori (1997) found that after 11 days of bed rest, there was an 18% decrease in LPL activity.
Along with the decrease in LPL activity, researchers Yanagibori et al., observed increases in plasma triglycerides and decrease in HDL cholesterol, which are two of the characteristics for metabolic syndrome. Similarly, researchers Wang and Eckel (2009) studied the effects of changing lipoprotein activity in mice, researchers found that when lipoprotein lipase in skeletal muscle was decreased, lipid separation into other tissues increased, glucose uptake was reduced, there was insulin resistance, and obesity. In addition, the mice with the decreased lipoprotein lipase levels developed hypertriglyceridemia and cardiac dysfunction (Wang & Eckel, 2009).

In addition, Hamburg et al. (2007), conducted a study evaluating the effects of five days of complete bed rest on the metabolic health of participants found that the participants experienced a significant increase in areas of cholesterol, triglycerides, glucose, and insulin resistance. These results confirmed the effects of sedentary behavior on metabolic health, and it was noted that there were no changes in body weight, which relates to the fact that health cannot be evaluated solely on appearances or physical observations (Hamburg et al., 2007).

When the body is sedentary, the muscles throughout the body are relaxed because they are not needing to contract to move or contract to hold itself up as it is resting. Long periods of sitting can lead to a significant decrease in contractile stimulation throughout the skeletal muscle in the body, causing a suppression of skeletal muscle (LPL) activity (Owen et al., 2010). LPL activity that occur within skeletal muscle is extremely sensitive to physical activity/inactivity (Bey & Hamilton, 2003). With less contractile stimulation, there is less lipoprotein lipase activity to aid in the
production of (high density lipoprotein) cholesterol (Owen et al., 2010). HDL cholesterol is useful to helping the body remove the buildup of plaque throughout the arteries, which works to protect against heart disease (Bhatt, 2018). If there is a decrease in the amount of HDL is being made, there is a higher risk for cardiovascular disease to occur (Bhatt, 2018).

What are the effects on the skeletal system?

Similar to most body parts, the muscular and skeletal system are ever-changing and constantly adapting to the needs of the body. If you don’t use it, you lose it. The body will not work and put energy towards a part of the body that does not need it. It is inevitable for the body to slowly deteriorate over time, especially with age, however, inactivity, accelerates this deterioration. People who sit more than five hours a day are at risk for losing 1% of muscle strength per day (Inyang & Stella, 2015). In addition to the reduction in capacity and strength of the muscle, the communication between the muscle cells and the brain cells also decrease as they are not used as much (Inyang & Stella, 2015).

It is specifically the bone mineral density that is decreasing over time with inactivity. (Caillot-Augusseau et al., 1998). Zerwekh and colleagues (1998) found that in healthy individuals 1-4% of bone mineral density was lost from bone in lumbar spine, femoral neck, and greater trochanter after a period of inactivity. One theory as to why this loss of bone mineral density occurs is that inactivity affects the processes and rates of bone breakdown and buildup, however, other studies (Kim et al., 2003, Smith et al., 2003, Zwart et al., 2007) have found that bone formation is for the most part unaffected
by inactivity. Sedentary behavior will still lead to a greater rate of bone resorption than formation which is how bone mineral density is lost after prolonged inactivity. However, even though inactivity has a slow deterioration effect on bone health, exercise did not have the ability to prevent reduction in bone mineral density (Tremblay et al., 2010).

Overall, there are many physiological health risks involved with sedentary lifestyles. The vascular, metabolic, and bone health risks seemed to all relate to and sometimes have an effect on each other. Inactivity is a risk factor for atherosclerosis, which has a negative effect on vascular health and is linked to coronary heart disease and inflammation (Powers & Howley, 2012, p. 318). Inflammation is a condition that is linked to several chronic diseases and conditions, some of which are associated with metabolic health, such as hypertension and metabolic syndrome (Mathur & Pedersen, 2008). Hypertension and metabolic syndrome coexist when there are abnormalities in the body that involve insulin resistance and elevated triglyceride levels. Insulin resistance can lead to type 2 diabetes and elevated triglyceride levels are associated with decreased levels of LPL (Hamburg et al., 2007). Decrease in LPL is directly and indirectly related to inactivity and it is linked to risk for several chronic diseases (Hamburg et al., 2007). Lastly, bone mineral density slowly deteriorates with inactivity due to the unbalanced rates of bone breakdown vs. bone build up as the bone is not used as much. It is clear that sedentary lifestyles are detrimental to the body due to the high risks for chronic diseases that result from inactivity.
Sitting and Exercise

Although time spent sitting can be harmful due to the fact that time is taken away from being physically active, time spent sitting can still be harmful even if individuals are physically active (Hamilton et al., 2004). It is commonly known that there is a relationship between sedentary behavior and increased risk for chronic diseases and premature mortality, however, the extent of this relationship has remained unclear.

A meta-analysis was done in order to illuminate this part of research on this topic, researchers questioned whether “physical activities attenuate, or even eliminate the detrimental association of sitting time with mortality” (Ekelund et al., 2016). Data from 16 studies were analyzed, totalling in approximately one million individuals examined. Researchers found that increased risk of premature mortality was significantly reduced at higher levels of physical activity, which is equivalent to 60 to 75 minutes of moderate intensity physical activity each day. Furthermore, risk of premature mortality was found to be eliminated for the individuals that were most active (Ekelund et al., 2016). For those individuals who engaged in 25 to 30 minutes of moderate intensity physical activity per day, the risk for premature mortality was smaller than it was for those individuals who engaged in five minutes of activity per day (Ekelund et al., 2016). The findings of this study indicate that the risk of premature mortality associated with long periods of sitting can be counteracted by physical activity. Findings suggest that in order to prevent risk of premature mortality, there needs to be a direct relationship between time spent sitting and physical activity. In other words, individuals that sit for long periods of time should be very physically active in order to
prevent the risks of premature mortality. Whereas, being adequately physically active will help to reduce risk, but not to a large extent, so therefore, someone who doesn’t have that increased risk due to sitting can afford to be adequately physically active.

With this knowledge of the dose-response relationship between physical activity and the risk posed by prolonged sitting, Katzmarzyk and co-researchers (2009) examined the risk associated with excessive sitting in individuals who meet the physically active recommendations yet sit for most of the day. These researchers explored the speculation that the benefits of recommended physical activity might not actually counteract the risk of mortality caused by prolonged sitting. In this study, researchers found that even the individuals that were meeting the recommendations of physical activity, had a strong association between sitting and risk of premature mortality (Katzmarzyk et al., 2009).

These findings reassure the claim that prolonged sitting is associated with risk for premature mortality, however it contradicts other studies previously mentioned which claim that physical activity can counteract these risks. While physical activity has many benefits to overall health, studies on restriction of normal activity show that inactivity leads to “changes to cardiac stroke volume and output, glucose tolerance, and clearance of triglycerides from triglyceride-rich lipoprotein particles as assessed by lipoprotein lipase activity” (Katzmarzyk et al., 2009, p. 1003). Physical activity surely helps to improve these factors, however, according to this study, other research has shown that there is evidence suggesting that physiological mechanisms of prolonged sitting are different than physiological benefits of physical activity (Katzmarzyk et al., 2009). As
mentioned earlier, these findings contradict the other studies claiming that a possible solution to the risks of prolonged sitting could be significant amounts of exercise. Unfortunately, these findings argue otherwise and leave us with the conclusion that not even exercise can reduce the risk of premature mortality.

Continuing on the idea that physical activity may not be as effective of a solution as previously thought, van der Ploeg et al. (2012) came to similar conclusions after doing a questionnaire with approximately 222,500 participants. The researchers suggest that even when individuals are engaging in recommended amounts of physical activity (150 minutes per week), there are still 6500 waking minutes that are important to consider. This is a great point that seems to be overlooked when it comes to this topic. We think several hours of stagnation throughout our bodies can be undone or counteracted with physical activity for a fraction of the amount of time spent sitting. This speaks to the mentality surrounding this topic acknowledging that most people are uninformed about this topic. Many studies show significant relationships between prolonged sitting and risk for premature mortality. The results of this study show that the relationship is independent of physical activity. In fact, the physiology of prolonged sitting and physiology of benefits of exercise are compared once again to demonstrate the parallelism between the two. Prolonged sitting are thought to affect the vascular and metabolic function; increased triglyceride levels, decreased levels of high-density lipoprotein cholesterol, decreased insulin sensitivity, and affect carbohydrate metabolism, changes in muscle glucose transporter protein content (p. 497-498). However, “studies have suggested that physical activity and sedentary behavior have
different influences on the body, supporting their independent effects on health” (p. 498). These findings reaffirm the conclusions drawn in the previous study and continue to make things unclear of what to inform people.

“The possible attributable fraction of sitting time suggested that sitting was responsible for 6.9% of deaths. The association between sitting and all-cause mortality appears relatively consistent across women and men, age groups, BMI categories, and physical activity levels and across healthy participants compared with those with preexisting cardiovascular disease or diabetes mellitus” (van der Ploeg, Chey, Korda, Banks & Bauman, 2012, p. 496). This is an issue that affects everyone and yet, the same patterns of inactive lifestyles continue because people don’t realize the major effects that are to come in the long run.

**Sitting and Intermittent Breaks**

Not only is it important to consider the amount of time spent sitting, but also how the prolonged time of sitting is accumulated. In other words, does the sitting occur in one full bout with no interruptions? Or are there breaks throughout the periods of sitting. The single bouts of prolonged inactivity decrease insulin sensitivity in healthy humans and have been proven to affect lipid metabolism as well (p. 661). It is no longer a rare event of sitting for a long period of time with no interruptions as technological advancements have made it almost too easy to do so. For many people, their jobs require them to be sitting at a desk for long periods of time and they might be too busy to take a break and move around. Because prolonged sitting has been shown to affect the metabolic and vascular processes within the body, researchers tested the effects of
breaking up long periods of sitting by evaluating adiposity, lipid, blood pressure, and glucose measures in a group of Australian participants (p. 661). This study resulted in the conclusion that “independent of total sedentary time, moderate to vigorous intensity time, and mean intensity of the breaks, more interruptions in sedentary time were beneficially associated with metabolic risk variables” (p. 661). The findings of this study are encouraging especially after learning about how some studies are finding that physical activity is not effective in fighting against the negative effects of prolonged sitting. Breaking up long periods of sitting with a bit of movement is very doable and can contribute to decreasing the negative effects caused by being sedentary.
Figure 2. Infographic about the effect that breaking up prolonged periods of sitting on risk for cancer (American Institute for Cancer Research, 2014)

**Sitting and Standing**

Replacing sitting time with standing or stepping is a common intervention for individuals who sit for long periods of time each day. This can be done with standing desks or other inventions that allow individuals to stand or step while getting work done. When it comes to the topic of replacing sitting time with standing, it is important to note that there are also health risks involved with static standing (Messing, Stock, Cote & Tissot, 2015). Epidemiologic, ergonomic, and biomechanical studies have found that prolonged standing is linked to health risks of the musculoskeletal and cardiovascular systems (Ngomo, Messing, Perrault & Comtois, 2008). In a study looking at North American workers with jobs that involve prolonged standing (health care, factory, and laundry workers) researchers found that static standing postures are associated with orthostatic intolerance, musculoskeletal symptoms, and decrease in blood pressure (Ngomo et al., 2008). In addition to musculoskeletal and cardiovascular health risks, static standing has been found to be associated with negative effects on reproductive systems (Messing et al., 2015).

On the other hand, studies have shown that while normal-weight children burn calories at a similar rate when standing or sitting, overweight and obese children use significantly more energy when standing compared to sitting (Wendel & Benden, 2017). Additionally, researchers looked at the differences in metabolic energy costs of college students while sitting, standing, and during a sitting/stepping protocol. In this study, the
standing and stepping protocol resulted in significantly greater metabolic energy cost than sitting (Fountaine, Johann, Skalko, & Liguori, 2016). This study shows that light physical activity breaks during studying or sedentary leisure time may help to disrupt the increase in health risks. This can be as simple as moving from a seated position to a standing position after reading a page or stepping in place during commercial breaks. Although the effects of static standing are less understood due to the lack of precise definitions of static standing, it is clear that the common problem between prolonged sitting and static standing is lack of movement (Wendel & Benden, 2017).

Section 3. Spreading Awareness to College Students

Perceptions of Sitting

Although this is not a new concept, many people don’t think of sitting to be a threat to their health (Flint, Crank, Tew & Till, 2017). Often times, people primarily associate terms such as exercise or diet with health but sitting is a less common topic of discussion when it comes to health. Many people don’t know much about effects sitting has on health nor do they do anything to prevent these health risks from occurring. It is important to look at the perceptions that people have on prolonged sitting because it is a good indication of whether people are aware of the issue or not, and to what extent do they know about the issue. Exploring the perceptions on excessive sitting can be helpful in determining how to take action on the issue. For instance, if people are not aware of the overall fact that prolonged sitting is associated with health risks, then more
awareness needs to be spread about the problem with too much sitting. On the other hand, if people are aware of the issue and continue to sit for long periods of time because they feel they have no other choice, it is important to spread awareness about the simple solutions to this detrimental problem.

A study was conducted in the U.K. about the perceptions of sitting for long periods of time. It recognized that there was a “lack of appreciation” for the health risks involved with prolonged sitting (Flint et al., 2017). Most of the employees of this study agreed that they felt they sat for too long at work and that there were negative symptoms associated with this excessive sitting times (Flint et al., 2017). However, the symptoms described were “neck and back pain, dry eyes, poor posture, weight gain, bad mood, a sense of sluggishness, fatigue, and reduced concentration” (Flint et al., 2017). The symptoms and feelings that the employees felt suggested that they didn’t know about the more significant health risks involved with excessive amounts of sitting.

People tend to know that excessive amounts of sitting cannot be good for overall health, however, it is easier for them to focus on the short term and present health factors as opposed to larger long term factors. Because of this, people push aside the negative factors associated with prolonged sitting because their work comes first and it is easier to prioritize the present issue than the potential issue. Therefore, while people do recognize the irritations involved with prolonged sitting, they are not as informed about the chronic diseases that they are building their risk for.

In addition, an Australian study looked at office-based employees’ perceptions of prolonged sitting and poor health. The employees were aware of the association
between prolonged sitting and poor health, but they believed the primary risks were musculoskeletal, decrease in motivation, and fatigue (Gilson, Burton, Van Uffelen, & Brown, 2011). Therefore, they did not know that prolonged sitting also leads to chronic diseases and premature mortality. These studies show an increasing awareness of the issue but a lack of knowledge about the severity of the effects. Some of the intervention strategies of the study included workload planning, environmental change, working on tasks on the move, and purposeful physical activity (Gilson et al., 2011). However the primary barrier to the implementation of these intervention strategies was found to be the perception that the individuals would need to compromise their productivity (Gilson et al., 2011). Once again, individuals are aware that there are health risks involved with excessive sitting, but not in great detail. Spreading awareness about the fact that the health risks of prolonged sitting include chronic diseases might be effective due to the increased severity of the risks. However, the perceived compromise of productivity is a serious challenge for people to overcome when trying to reduce sitting time, especially in the workplace.

**Sitting in the Life of College Students**

If people who work in sedentary environments are not fully aware of the detrimental health risks involved in prolonged sitting, then it is unlikely that college students would be aware, as well. Traditional college students have been in school their whole lives and haven’t had the time to learn about issues such as this or research the topic. Furthermore, schools are sedentary environments in itself as students are required to sit all day long. When it comes to the topic of prolonged sitting, students live
a very similar lifestyle to employees of sedentary environments (who spend approximately 75% of their day sitting) as they sit during class, while completing homework and studying, and during leisure relaxation via screen time (Fountaine et al., 2016). It is essential to inform students about how to adjust their lifestyles to address the risk of prolonged sitting before they enter the workforce where they can potentially continue to live and work in a sedentary environment. Especially because raising awareness of the consequences of too much sitting comes too late for many individuals (Dabundo et al., 2015).

Going to college is a big stepping stone that involves a lot of change for most people. More specifically, college is a time where individuals gain more independence and start to make decisions and choices for themselves. College is an important time to learn healthy habits that can be practiced throughout life, yet, college students spend significant amounts of time sitting during courses, while studying, and as a part of leisure (Butler, Ramos, Buchanan & Dalleck, 2018). Although college students receive health education and health promotion, research has found that the education college students receive may not fully capture the severity of the risks involved with prolonged sitting (Dabundo et al., 2015). In other words, college students learn about the importance of exercise and healthy diets, but they might not be aware of the chronic health risks related to long periods of sitting or how much time they actually spend sitting.

Data on sedentary behavior in college students are somewhat limited, but Fountaine and others (2016) have shown college students to spend at least 3.3 hours
per day to educational matters and 2-3 hours per day to screen time leisure (Fountaine et al., 2016). Another study found that college students report spending approximately six waking hours sitting each day (Maher, Doerksen, Elavsky & Conroy, 2014). It would be difficult to evaluate the day of a college student as there is so much variety in each student’s day depending on their area of study, whether or not they work, what type of jobs they have, what they do in leisure time etc. Figure 2 shows a breakdown of a typical college or university student on a weekday from the Bureau of Labor Statistics. Despite the common belief that college students are crunched for time, they also have considerable discretionary time (Buckworth, J. & Nigg, C., 2004).

**Time use on an average weekday for full-time university and college students**

![Pie chart showing time use of full-time college student on average weekday.](chart)

**NOTE:** Data include individuals, ages 15 to 49, who were enrolled full time at a university or college. Data include non-holiday weekdays and are averages for 2011-15.

**SOURCE:** Bureau of Labor Statistics, American Time Use Survey

Figure 2. Pie chart showing time use of full-time college student on average weekday. (Bureau of Labor Statistics, 2015)
Screen time has and continues to increase due to developments in devices and the internet. In a study of the relationship between cell phone use and physical activity and sedentary behaviors, researchers found that individuals who used cell phones at a higher frequency were more prone to omit physical activity for sedentary behavior on the cell phone that those who use cell phones at lower frequency (Lepp, Barkley, Sanders, Rebold & Gates, 2013). Recent popularity of social networking sites such as Facebook and Twitter could have a heavy influence on college students, thus further encouraging the incorporation of sitting time into the lifestyle of college students (Fountaine et al., 2016). In addition to sitting times specific to college students, people in general will spend time sitting during commutes, eating, breaks between classes, and socializing.

In addition, the lack of clarity among the different research studies makes it difficult to determine a solution to this problem. The issue is not a new discovery, yet, people continue to live in patterns that increase the problem. Clarity on the issue might encourage people to acknowledge the problem of prolonged sitting and take action in implementing solutions. “Participants commented that any strategy to reduce sedentary behavior at work must compete with established routines and habits. Finding the motivation to initiate a new behaviour was acknowledged as a significant challenge especially alongside competing priorities” (Flint et al., 2017, p. 1163). People who are already sitting for long periods of time at their jobs are going to be hard to reach out to because of their established routines and habits that incorporate that much sitting. Informing college students is a perfect opportunity to take advantage of people entering
the workplace and who have not had the opportunity to create their habits yet.

Providing this information to them at this point in their lives can hopefully have an impact on the workplace habits they will create in the future.
Methods & Goals

The goal of my thesis was to research and spread awareness about the health risks involved with prolonged sitting. In order to do this, I created posters and flyers about the issue and posted them on campus. I used a program called Canva to create the posters and flyers. Canva is a graphic-design website that provides tools for professionals as well as non-designers to create beautiful designs on a variety of layouts. Canva provides many templates in many different layouts that users are free to use. One of the templates I came across was a video game themed poster about video games, which helped me determine a potential theme behind my poster. I decided that a video game theme might be an effective way to get my message across to college students because the theme had a parallel to my objective and it is visually appealing and intriguing. This theme worked well with my objective because in video games, the characters have multiple lives but this life that we live is not a game, and thus we have to live it well. Part of living our lives well involves taking care of our bodies. Health risks in general create a lower quality of life that would decrease our abilities to live life as best as we can.

My main focus in creating the poster was to include short facts about the health risks involved with prolonged sitting. I chose to include facts such as the average college student spends 12 hours per day sitting (Moulin & Irwin, 2017), the health risks that prolonged sitting can lead to, and the time use of a college student on a weekday. In going through the researched facts, I wanted to include facts that had caught my attention when I first started looking into the issue because I am a part of my target
population. The main message of the poster was “You only get one life, don’t waste it sitting around”, this was a way for me to incorporate my message with a video game reference. The poster design is shown in Figure 3.

My main focus in creating the flyer was to communicate the issue with prolonged sitting with more detail than the statistics displayed on the poster. While the poster served as an opportunity to catch the attention of bypassers with the bold and shocking statistics, the flyers served as a way to provide more information to those who were interested in the topic after reading the poster. In the flyer, I included an explanation of the issue broken down into the problem and the solution. I discussed how sitting has become a problem, some information about the fact that exercise isn’t an effective mode of prevention for the health risks of prolonged sitting, and a few statistics. Canva was also used to create the flyers, but it did not follow the same video game theme because the flyers needed to be easier to read through. The flyer design is shown in Figure 4.

Another part of the goal of this thesis was to post the posters and flyers throughout campus. In order to do this, I first contacted the Werner University Center and Health and Wellness Center about posting my posters on the bulletin boards in their facilities. Both sites responded with the explanation that my items could only be posted on the community bulletin boards designated to non-Western Oregon University sponsored events. Therefore, there were only two bulletin boards on campus that I could display my products; the first floor of the Werner University Center and the East entrance to the Hamersly Library. I had my items printed by the print shop on campus
and then I proceeded to display them on the appropriate bulletin boards for a two week duration. Pictures of the displays are shown in Figure 5.
Figure 3. Poster design

YOU ONLY GET ONE LIFE

THE AVERAGE COLLEGE STUDENT SPENDS 12 HOURS PER DAY SITTING

AVERAGE WEEKDAY FOR COLLEGE STUDENTS

HEALTH RISKS OF PROLONGED SITTING

1. OBESITY
2. MUSCULOSKELETAL DISORDERS
3. TYPE 2 DIABETES
4. CARDIOVASCULAR DISEASES
5. CANCER
6. PREMATURE MORTALITY

TAKING BREAKS DURING LONG PERIODS OF SITTING CAN REDUCE HEALTH RISKS

DON'T WASTE IT SITTING AROUND
SOLVING THE SITUATION

The Problem
Due to changes in lifestyle demands and developments of technology, the world we live in encourages us to sit for excessive amounts of time. In the home, work places, school, transportation, and recreational venues, opportunities to sit are readily available and in some cases required. This is a problem because excessive sitting has been found to be associated with several health risks.

Health Risks
- Cardiovascular Disease
- Obesity
- Musculoskeletal Disorder
- Type 2 Diabetes
- Cancer
- Premature Mortality

250,000 premature deaths per year due to sedentary behavior

50% increased risk of premature mortality found in individuals who spent majority of their day sitting

The Solution
While exercise has significant benefits to health, research has shown that the positive effects of exercise cannot counteract the negative effects of excessive sitting. The obvious solution to reduce health risks caused by sitting is to reduce the amount of time spent sitting. As mentioned previously, sitting is ubiquitous, therefore reducing sitting time isn’t as simple as it seems. Fortunately, studies have shown breaks in sedentary time to be beneficial in reducing the negative effects on health.

How much time do you spend sitting?

- Sitting (9 hr): 31.6%
- Sleeping (8 hr): 30.6%
- Work (4 hr): 31.5%
- Eating (1 hr): 4.2%
- Leisure (1.5 hr): 6.2%
- Physical Activity (3 hr): 13.9%
- Screen Time (3 hr): 12.6%

Incorporating movements as simple as standing from sitting or taking a step throughout long periods of sitting can help decrease health risks.

Figure 4. Flyer design
Results

This thesis did not follow a typical scientific research test as it was more focused on the literature review write up and spreading awareness of the issue. The main product of this thesis was the research literature review and the use of the learned
information in spreading awareness to college students. Therefore the results of the thesis include the outcome of the attempt to spread awareness throughout campus. This was measured by the amount of flyers that were taken throughout the time it was posted on the community boards. Although this method of measurement is not the most accurate in determining how many people were impacted by the poster, there weren’t too many other options to gauge effectiveness due to the nature of this project.

Unfortunately, only two information flyers were taken from the community board in the Werner University Center and one information flyer was taken from the community board in the Library throughout the duration of the posting. However, I did have one encounter with students who were standing around my poster and flyers discussing the content. During one of my trips to check the status of the flyers, I was surprised to see a group of five college students standing around the area of the bulletin board that my project was posted. As I got closer, I heard them discussing the content that was on the poster, more specifically the statistics included on the poster. I talked to the students about what they thought about the facts that they were reading and they explained that it was hard to believe the statistics provided on the poster were true. One of the topics they were discussing was the statistic that college students spend 12 hours per day sitting. When I explained to them the sources that I retrieved my statistics from, they were shocked to learn about how serious the issue of prolonged sitting is. The picture of the students by my product display is shown in Figure 6.
Figure 6. Students viewing and discussing poster and flyer displayed to spread awareness about the health risks involved in prolonged sitting.

**Discussion**

This project focused on addressing the health risks of prolonged sitting specifically in the population of college students. Through the research done on sedentary activity and excessive sitting, it was clear that the issue is significant and needs to be addressed. Research has shown that people are aware that there are health risks involved with prolonged sitting, however individuals do not understand that the severity of the risks that increase as a result. In addition, it has been found that college
students sit nearly as much as individuals who have sedentary jobs. For that reason, as well as the fact that college is an important time to learn life long habits, targeting the college student population with this project seemed to be very beneficial.

The fact that the project resulted in a few flyers taken indicates that there were at least a few people that were intrigued by the poster enough to take a flyer with more information on the topic. In addition, the posters were effective in catching the attention of college students as there were a handful of students standing around the poster discussing the information displayed. These results indicated that the project was able to impact a few students at Western Oregon University which is better than none. As mentioned earlier, it was also difficult to measure something like spreading awareness, therefore the project could have potentially impacted more students.

There were many limitations that I encountered throughout the execution of this process. One of the main limitations I encountered was the posting opportunities throughout campus. During the initial planning of this project, I intended to post the posters and flyers on more of the bulletin boards throughout campus in order to increase ability to impact students. Especially locations such as the Health and Wellness Center because one of the unexpected findings in my research included the fact that the benefits of exercise cannot counteract the detrimental effects of prolonged sitting. However, due to the rules and guidelines of postings at Western Oregon University, my posters and flyers were restricted to the community boards which were filled with many other postings from non-Western Oregon University sponsored posters.
Another limitation for this project is the medium that was used to spread awareness. Posters and flyers are both very effective means of spreading awareness, however, due to the minimal opportunities to display the products, the difficulty in evaluating the medium, and the target population, a different medium could have created a better outcome. In future projects, it is important to take into consideration the desired methods of interaction among the target population. College students are in the age group that spend a lot of time on their phones and more specifically on social media. If the products were posted on social media instead of posters and flyers, they could have potentially had a greater impact on college students. In addition, with advancements in technology, there are features that show how many people viewed certain products throughout certain media which would be slightly more helpful for determining effectiveness.

**Conclusion**

The health risks involved with prolonged sitting is an important issue to spread awareness about, especially as it continues to become more prevalent in society. Excessive sitting significantly increases risk for chronic diseases, but these risks can also be reduced by simply taking breaks throughout long durations of sitting. Sitting with intermittent breaks or sitting with incorporated sitting is the best and most simple solution to the problem of too much sitting. Another important finding to keep in mind is that the benefits of exercise do not counteract the detrimental effects of prolonged sitting. Furthermore, college students exhibit poor physical activity maintenance,
therefore indicating the necessity of spreading awareness throughout campus. There were a few students who took a flyer from the display and a handful of students who were intrigued by the poster and discussing it. Methods of spreading awareness to college students were not completely ineffective, but could be improved to have a greater impact. Potential changes for future projects may include a change in medium and/or change in display sites.
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