# DIFFERENCES IN TOTAL AND OUTDOOR SPECIFIC PHYSICAL ACTIVITY BETWEEN TWO GROUPS OF COLLEGE STUDENTS: MOUNTIAN CHALLENGE STUDENTS AND NON-MOUNTIAN CHALLENGE STUDENTS

A Report of a Senior Study

by

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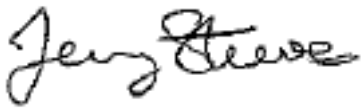

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# ABSTRACT

The objective of this study was to determine whether or not Mountain Challenge Students spend more time engaged in physical activity than non-Mountain Challenge Students on the Maryville College campus. This research question is based on the premise that more time an individual spends outdoors, the more likely they are to be engaged in physical activity. To test this hypothesis, a total of 24 Maryville College Students, Mountain Challenge Students n=15 and non-Mountain Challenge Students n=9, were recruited and assigned to wear an Omron HJ-325 pedometer and an ActiGraph GT3X accelerometer for a one week observation period. In addition, participants self-reported any intentional physical activity engaged in. Through the analysis of the objectively measured physical activity, it was found that the Mountain Challenge Students did engage in more physical activity than the non-Mountain Challenge Students as well as having a greater percent of outdoor activities, despite no differences in self-reported physical activity, TV viewing, or total number of physical activities engaged in. It was concluded that greater amount of time spent outdoors may be related to increase levels of physical activity in college students.

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# CHAPTER I

## INTRODUCTION

In an annual report released for the year 2015, 23.5% of Americans report being physically inactive. According to this report, this meant that they did not engage in the recommended thirty minutes of physical activity per day within the past thirty days (United Health Foundation, 2015). The prevalence of inactivity is not uniform across the United States, and may be highly dependent on the region. For example, Colorado has a 16.4% prevalence of physical inactivity compared to Mississippi which has a 31.6% prevalence of physical inactive (United Health Foundation, 2015). These levels of inactivity are concerning, and understanding the reasons behind them may allow for a better opportunity to solve the problem of inactivity. One explanation for the stark differences in the prevalence of inactivity between Colorado and Mississippi could be the simple basis of the region in which the two states are located. With both states located on opposite sides of the country from one another, there are several factors that differentiate the levels of physical activity between the two. A prime example would be the climate and terrain of the state(s), Colorado is a very mountainous state that provides an amplitude of opportunities to partake in activities such as hiking, skiing, and snowboarding. However, looking at the state of Mississippi, which is in the eastern gulf

of the United States, and has a climate that is known to be dry and hot, there are fewer opportunities to partake in outdoor activities due to not only the terrain but the climate as well.

According to health.gov guidelines, an online health database, adults should aim to get thirty minutes a day, or 150 minutes per week of moderate to vigorous physical activity, and children should be getting a minimum of an hour of physical activity per day. (Office of Disease Prevention and Health Promotion, 2008) In a study that sought to determine the percentage of adults and children that actually meet the physical activity guidelines of 150 minutes per week it was found that 42% of children adhere to the guidelines while only 6-8% of adolescents and only 5% of adults completed the required amount of physical activity. (Troiano et al., 2008) Considering the low levels of individuals meeting the guidelines, one concern is whether our nation is knowledgeable about the physical activity requirements and the health benefits associated with achieving them. In a study using 2718 students, only 3.6% of the students were able to successfully identify the daily requirement for moderate to vigorous physical activity (MVPA). (Marques, Martins, Sarmento, & Rocha, 2015). Partaking in the recommended physical activity has been proven to be vital in lowering the risks of cardiovascular disease (CVD), type 2 diabetes, and hypertension, along with increasing overall life expectancy. (U.S. Department of Health & Human Services, 2016) When moderate to vigorous physical activity is done on a regular basis, there is an increase in the hearts strength, functionality, and efficiency. With this increase in the strength of the heart along with the effectiveness, there is the direct decrease in the chances of an individual suffering from coronary heart disease (CHD) and cardiovascular disease (CVD). In addition to

combating the negative effects of diseases brought on by physical inactivity, regular bouts of exercise help improve one's physiological health as by promoting increases in muscular endurance, strength, flexibility, contributing toward joint health, and slowing or reversing muscular degeneration (O'Donovan et al., 2010).

With the high levels of physical inactivity across much of the United States, it is important to understand the dangers that are associated with this inactivity. According to the World Health Organization, physical inactivity is the cause of approximately 3.2 million deaths per year (Physical Inactivity: A Global Public Health Problem, 2014). Per publications by the Department of Health, lacking physical activity has been linked to the increased risks of cardiovascular disease, cancers, and various other congenital diseases. (Department of Health, 2015) In addition to illnesses such as CVD and diabetes, the prevalence of sedentary lifestyles is leading to an increase in the obesity epidemic within not only the United States, but globally as well. In accordance to the findings of the NCHS briefing of 2015, 36.5% of all American citizens are obese. (Ogden, Carroll, Fryar, & Flegal, 2011) It is important to also analyze the effects of our societies physical inactivity on our youth. Approximately 30% of the 40 million children globally who are obese, are from the United States. (McHugh, 2016) One of the main causes of childhood obesity is the imbalance of caloric intake and expenditure (McHugh, 2016), further supporting the claim that physical inactivity is leading our nation down a path of obesity and disease.

Knowing that there is such a high prevalence of obesity and physical inactivity within our nation, there needs to be a light shed on possible solutions to overcome both of these epidemics. There are a wide range of possible solutions that society can use to

avoid physical inactivity and obesity such as individual, and community level interventions, policy and environmental changes, and understanding more about the determinants of physical activity.

There is an array of determinants of daily physically activity, such as occupation, culture, climate, access to facilities, personal preference, and the introduction of new technology into society. An individual's occupation may provide obstacles to them meeting the physical activity recommendations, because the majority of occupations require people to be inside bound to a desk. (Burton & Turrell, 2000) However, in another study that analyzed physical activity within the workplace, individuals who worked in blue-collar jobs, some of which may still allow workers to be about side doing manual labor, tended to have a higher levels of occupational activity than peers working white-collar office jobs. (Steeves et al., 2015) In addition to the occupational impact on physical activity, the environment in which an individual lives in is also a major factor in whether or not they are able to meet the recommended time for physical activity. Research has shown that neighborhoods that are located within the inner city lack the resources, such as green spaces, to provide children physical activity opportunities that promote a healthy lifestyle. (Cohen et al., 2014) It is vitally important for children to have the ability to get outdoors and play due to the fact that when a child remains indoors, they have a greater tendency to have increased sedentary behaviors and other unhealthy lifestyle behaviors that lead to the onset of obesity. There seems to be a relationship between the lack of outdoor spaces and indoor technology use, both of which contribute to a sedentary lifestyle, and an increase in the prevalence of children that are suffering from heart problems, diabetes, and various other illnesses (Cohen et al., 2014). Further

studies that focus on children and obesity found that children are more likely to be more active if they are in an open, green environment (European Food Information Council, 2006). Researchers have identified providing children access to green space, such as pocket parks, within urban areas, using vacant or abandoned lots, as a solution to increasing activity levels (Cohen et al., 2014). Per the 2014 report by the Outdoor Foundation, many black and minority ethnic communities that are deprived of the necessary outdoor resources and green spaces are further deprived of the opportunities to get the required amount of physical activity (The Outdoor Foundation, 2014). To solve this issue, it is important to introduce pocket parks into lower income communities so that the inhabitants of these areas will have the access to natural spaces to be active since their neighborhoods are generally not as conducive to physical activity. Pocket parks are a simple and innovative way to turn an area with little-to-no green space into a place where children can run and play. Individuals gravitate towards these pocket parks and are more than willing to walk approximately 0.25 miles or more to visit these parks (Cohen et al., 2014). Because the amount of time spent in nature and outdoors is directly related to the amount of outdoor resources and greenspaces available. (The Outdoor Foundation, 2014) promoting physical activity can be as simple as having access to green space to walk and exercise.

The act of going outdoors is beneficial to the human body and mind. One study that analyzed the effectiveness of indoor versus outdoor physical activity and the effects it has on mental well-being found that participating in moderate to vigorous physical activity outdoors has the ability to decrease the mental stress and fatigue that could lead to physical illnesses (Coon et al., 2011). It is documented that 40-50% of all individuals

that hold a gym membership are likely to void the membership within the first year, whoever there is no membership required to go outside and exercise, therefore, an outdoor exercise regimen, or program maybe more likely to be successful in terms of long-term adherence than an indoor program. (Coon et al., 2011) In further support of the benefits of outdoors, it is also stated that individuals that participate in physical activity outdoors are 24% more likely to remain physically active. (The Outdoor Foundation, 2014)

It is believed that this success within the outdoor programs directly relates back to the psychological benefits of being outdoors. (Coon et al., 2011) Through a series of seven studies that were conducted with children, there are several physiological benefits that are seen within individuals that partake in moderate to vigorous physical activity outdoors. There is an increased prevalence of the overall amount of time that children actively partook in physical activity when they were outside in comparison to when the children attempted to be active indoors. (Gray et al., 2015) Through the studies, the children engaged in anywhere from 2.2 to 3.3 times more physical activity when it was conducted outdoors. (Gray et al., 2015) In addition to being more active in an outdoor environment, it was also found that the children that spent at least an hour a day outdoors were more likely to decrease the amount of time being sedentary throughout the day by a total of 14%. When physical education classes were facilitated outdoors, the children showed a decrease of 10% in total inactive time. (Gray et al., 2015)

Not only has outdoor physical activity been proven to be beneficial and vital to the well-being of children, it is also needed within the elderly community. Individuals that are progressing in age are found to have insufficient levels of necessary vitamins to

ensure optimal health. (Kerr, 2016) Being granted access to an outdoor environment, the participants of the study are then exposed to direct contact with sunlight; therefore, are exposed to Vitamin D, and its side effect of increased protection against the chronic illnesses. Elderly participants who were exposed to outdoor activities also had decreased levels of depression. (Kerr, 2016)

A report from 2014 indicated that only 49.2 percent of the American population participated in an outdoor activity at least once throughout the year of 2013. Approximately 8.1 million more Americans began to participate in outdoor activities in 2014. (Gordon, Chester, & Denton, 2015) There are various factors that influence whether an individual, or subset of individuals, is physically active outdoors, such as age, ethnicity, annual household income, and education. (Gordon et al., 2015) Of the 155.7 million Americans that were active outdoors in the year 2013, individuals of the Caucasian ethnicity accounted for approximately 70% of the participants, followed by African Americans at 11%, Hispanic at 8%, Asian/Pacific Islander at 7% and other at 4%. Age was also a major determinant of outdoor activity. Only 9% of 13-17-year-old Americans while 33% of those 45 years of age or older participated in outdoor physical activity. In addition, those with higher education and income where more likely to regularly participate in outdoor physical activity. 15% of Americans that had an average income of less than $25,000 a year participated in outdoor activity, while 30% of Americans that had average income of $100,000 or greater a year engaged in physical activity outdoors. (Gordon et al., 2015)

Approximately twenty-five years ago a group of students and staff on the Maryville College campus established the Mountain Challenge Program. The Mountain

Challenge mission statement is "*We provide high quality, safe outdoor experiences designed to change the world for the better, one person at a time."* (Maryville College, 2017) This is done through several on-campus initiatives such as Camp 4 which is held every Wednesday at the Crawford House between 3:30 and 6:30 in the fall and the spring. While at Camp 4, students have the opportunity to partake in various outdoor activities such as scaling the alpine tower, participating in yoga or group fitness classes on the deck, bouldering in the bouldering cave, and participating in small activities such as cornhole or soccer. In addition to Camp 4, throughout the year, there are numerous open trips lead by Mountain Challenge student employees that all students on campus are encouraged to participate in such as hiking, caving, rock climbing, open water paddling, white water rafting, and bicycling. The Mountain Challenge Program student staff aim to engage the student body in outdoor physical activity on a regular basis, and therefore may be more likely to be engaging in outdoor physical activity themselves.

Therefore, the purpose of this study is to measure the physical activity levels of Mountain Challenge student employees and a group of non-Mountain Challenge Maryville College students to determine whether or not there are any differences in total physical activity levels, or participation in outdoor physical activity between those students who work and likely play outdoors a lot to students who may not work and play outdoors a lot. Through the process of the study, the participants will be asked to wear an accelerometer and a pedometer to track physical activity levels. In addition to the use of the pedometers and accelerometers, the participants will also be asked to complete a physical activity log in which they will they record their times of physical activity throughout the day for a one week period. Upon completion of the week-long trial, the

participants will then be asked to complete an Oxford Happiness Survey that will assess their levels of happiness. Within the survey, there is a section that will also ask about sustainability practices.

Throughout the study, there are some limitation that may cause a shift in the validity and reliability of the data that is collected. The activity log in which the participants are asked to complete is one that is entirely self-reported. With that being said, there is no support for the validity of the information that will be returned from the participants to the researcher other than the data that is collected from the Omron Pedometer and Actigraph accelerometer. While the pedometer and accelerometer possess the ability to validate whether or not the individual was active when they claim, the devices do not hold the ability to determine where the participant partook in the activities.

# CHAPTER II

# LITERATURE REVIEW

There is evidence to suggest that physical activity levels are influenced by the environment in which the child participates in the activity (Jones, Coombes, Griffin, & van Sluijs, 2009). Furthermore, some research supports that children that are able to go outdoors and play display a greater level of physical activity than those who do not go outdoors. To evaluate the relationship between environmental characteristics and health enhancing moderate to vigorous physical activity (MVPA) bouts, a 2007 study, in Norfolk, England used a sample of 100 children (47 male and 53 female) ages 9-10 years (Jones et al., 2009). All of the children were assigned a waist-worn ActiGraph GT1M accelerometer for four consecutive days to record physical activity throughout the day, and a wrist-worn Global Positioning System (GPS) to track the location of the physical activity. Bouts of 5 or more minutes of MVPA were identified from the accelerometer, and all accelerometer data were matched with GPS locations to determine the location of where different activity intensities occured.

The results from the data collected through the Actigraph and GPS systems indicated that the children that spent more time outdoors participated in higher levels of moderate to vigorous physical activity. The data that was collected from the GPS further indicated the higher levels of physical activity resulted from the children playing in

garden areas and neighborhood streets, especially in children that live in more urban areas. The data also inferred that girls who spent more time outdoors, and individuals that lived in more rural areas who spent more time outdoors were also more likely to have higher levels of moderate to vigorous physical activity.

While there are previous studies that analyzed and determined that there is indeed a correlation between outdoor time and physical activity, there is little research on the location of play and activity. Therefore, the research team aimed to determine whether the physical location; street, park, backyard, etc., had any influence on the level of physical activity within children. These results highlight the importance of gardens and greenspace for promoting children's physical activity. Within this research, there were several limitations; such as small sample size, evaluating children in the summer months, and the criteria that bouts of physical activity needed to last more than five minutes to be analyzed. Each monitor also had a limitation: accelerometers do not capture cycling activities well, so any cycling behaviors may have been misclassified, and GPS data was missing from 34% of the activity bouts because the GPS device was frequently removed for swimming or team sports (Jones et al., 2009).

Data collected from preschoolers supports the relationship between time spent outdoors and the increase in the level of physical activity (Cleland et al., 2008). To further determine the effect that being outdoors has on physical activity and well-being on the children, 548 children, whom were involved in the Children's Living in Active Neighbourhoods (CLAN) study in Melbourne, Australia, were used to determine if being outdoors boosted levels of physical activity, and was related to obesity rates. The children

that participated in the study were classified into two groups, younger (ages 5-6, n=188) and older (ages 10-12, n=360) children.

In order to determine the physical activity levels of the children, each child wore a waist-worn Actigraph 7164 accelerometer for an eight-day period. While the accelerometer is able to collect all of the data in relation to the movement of the children, it is unable to determine the location of the activity. The parents were all assigned questionnaires that were to analyze the amount of time the children spent outside, whether it be after school or on a weekend, and to specify the amount of time spent outdoors during warmer months versus cooler months.

Through the analysis of the data that was collected via accelerometry and the questionnaires that the parents were assigned, it was determined that the children spent more time outdoors during the warmer months compared to the cooler months. Average time spent outdoors, measured in hours, in warm weather on weekdays was $8.0 \pm 5.0$ for younger boys and $9.1 \pm 5.9$ for older boys. Conversely, the average time spent outdoors in the warmer months on the weekdays was $7.0 \pm 5.2$ for younger girls and $6.7 \pm 5.0$ for older girls. During the weekends of the warmer months there was an increase in the time spent outdoors being that younger boys spent $10.0 \pm 4.3$ hours outdoors and older boys spent $9.8 \pm 5.2$ hours outdoors. There was also an increase in the time spent outdoors within the female participants with the younger girls averaging $9.2 \pm 4.4$ hours outside and older girls $8.6 \pm 4.8$ outdoors. Within the cooler months, there was a significant drop in the amount of outdoor time within the male and female groups. On average, the younger boys spent $3.0 \pm 2.5$ hours outdoors on the weekdays and older boys $4.0 \pm 3.2$ . On the weekends, younger boys spent $5.2 \pm 2.9$ hours outdoors and

older boys spent $5.5 \pm 3.3$ outdoors. As in the male group, the females also experienced a drop in the amount of outdoor time during the cooler months. The younger girls spent $4.0 \pm 3.2$ hours on average outdoors during the weekdays and the older girls spent 2.6 $\pm 2.4$ hours outdoors. On the weekends younger girls averaged $4.3 \pm 2.9$ hours and older girls $4.2 \pm 2.9$ hours spent outside.

As seen in the data presented, within the younger group, there was very little difference between the boys and the girls in the amount of time spent outdoors, however, within the older group, males spent more time outdoors than the females did . This is seen through the analysis of the time spent outdoors and the amount of MVPA participated in between older boys and girls. While older boys averaged more time outdoors on weekends, $9.8 \pm 5.2$ , they also averaged a higer rate of MVPA, $257.2 \pm 100.3$ minutes per weekend compared to the older girls who spent on average $8.6 \pm 4.8$ hours on the weekends outdoors and accumulated $216.9 \pm 104.8$ minutes of MVPA per weekend. The overall findings of the study suggest that children that spend more time outdoors partake in a higher level of physical activity and MVPA. Within the study, it is noted that there are several limitations that may influence the results gathered. The time spent outdoors was not validated since it was self-reported by the childrens parents, therefore, possible bias may have arisen. In addition to the self-reported nature of the data collection, the researchers also claim that there may have been a bias within the selection of the group of participants as well, as only half of the participants participated in the follow-up (Cleland et al., 2008).

Research on preschoolers has shown a strong relationship between the environment in which they are exposed to and the amount of physical activity that they

participate in (Boldemann et al., 2006). Eleven Stockholm preschools were assessed for the amount of open space that was available, the amount of vegetation present within the play area and the structures that were provided for the children. In addition to the environmental audit, 197 students, and their parents, were asked to participate in the study. The students height, weight, and BMI were measured, and the parents completed questionnaires about their childs physical activity behaviors. The questions asked how much time each child spent engaging in sedentary activities, physically active activities outside the house, and the average daily activities such as walking, shopping, driving in the car, etc. Additionally, childrens pre-school-related physical activity was objectively monitored. Each child was assigned a Yamax Digiwalker SW-200, MLS 2000 pedometer which recorded the number of steps they took per day for a period from May-June 2004. The pedometers were fastened to a belt and placed around the child's waist, and were administered to the children upon arrival to the preschool and removed upon dismissal from school. At the end of each day, the steps were recorded for each student and the pedometer was reset. Over 90% of the children wore the pedometers for at least 5 days. The time, location, and type of activity engaged in throughout the day was also recorded on the logs.

After analysis of the recorded data, step count and activity logs, researchers reported a direct and positive correlation between environment and step count; meaning that when the children were exposed to outdoor activities and spaces, they participated in a greater frequency of physical activity. In addition to an increased prevalence of physical activity being outdoors, the condition of the outdoor environment also had an influence on the amount of physical activity undergone. These claims can be supported through the

data collected upon the comparison of the preschool sites. For example, looking at preschool site 9, which received a score of high on the outdoor play environment survey, the girls attending the school average 21.0 steps/minute and the boys average 23.9 steps/minute. However, when looking at preschool site 7, which scored low on the outdoor play environment assessment, the girls only average 15.7 steps/minute and the boys 15.6 steps/minute. Further analysis and comparisons of the activity logs and pedometer-based evidence unveiled the fact the environment in which the children were exposed to had the potential of yielding an additional 1500-2000 steps/day/child. Through the data provided it is apparent that the researchers claims that the environment in which a child is exposed to has the potential to either increase or decrease the amount of physical activity that they engage in.

Within this study, there are several limitations that are identified and cautioned against by the researchers. Pedometry is known as a reliable and valid tool for tracking physical activity, however, the intensity of the activity that is undergone is not recorded, unlike with the use of accelerometry. Another limitation directly related to the use of the pedometer is that the pedometer is not capable of measuring activities such as swinging. The staffing situation within some of the preschools also proved to be a limitation. On certain days, the school was understaffed and the children were then restricted to only certain areas to play rather than having full range to roam further limiting their physical activity (Boldemann et al., 2006).

There are various determinants to the amount of physical activity that children partake in (Loucaides & Jago, 2006). In order to determine the relationship between then environment, social and psychological factors and physical activity, 104 Cypriot children,

aged 5-6 years of age, and 70 of their parents were asked to wear a Yamax Digiwalker (model DW-200) pedometer for five consecutive week days. The pedometer was used to count the steps in which the participants took each day. In addition to the pedometers, the participants were asked to keep a self-reported log of the steps taken on each day. While completing the five-day experimental period, the parents were also instructed to complete reports on environmental variables that could have a possible impact their childs level of physical activity.

Through the analysis of the self-reported step logs, it was shown that there is a higher prevalence of physical activity within the adolescent male population than that of the adolescent female population. This claim is upheld by the data that presents boys taking $15{,}284 \pm 3{,}616$ steps per day while girls averaged $12{,}282 \pm 2{,}956$ steps per day. Further analysis of the reports completed by the parents, suggests that the findings of the current study coincide with those completed within the United States in the sense that outdoor time is proven to be a vital correlate in the amount of physical activity that a child partakes in. The study claims that the time of year and the location of the physical activity accounts for approximately 75% of variance in recorded physical activity.

The study has various cautions/limitations that are associated with it. These limitations include a small sample size, the use of a single geographical region, and the low response rate that potentially led to a selection bias. With the implementation of a small sample size within a single geographical area, it is hard for the researchers to determine whether or not the geographical location of physical activity has an effect on the amount of physical activity engaged in and the intensity of the activity as well (Loucaides & Jago, 2006).

Research shows that there is a great correlation between the home environments in which a child is exposed to and the physical activity in which they engage in (McKenzie et al., 2008). In order to prove, or disprove, these findings, at-home observations of 139 Mexican-American children, of which 69 were boys and 70 were girls having a mean age of 6, took place. During the home observations, the trained observers, three bilingual females, analyzed social and environmental factors that had the potential to act as barriers to the children participating in physical activity. During the two 30-minute observation periods, the observers recorded the times in which the children were active, the locations of the activities, and whether anything acted as a prompt for physical activity. While observing the children, the observers would implement the use of prompts in an attempt to get the children to remove themselves from media and engage in physical activity.

The total amount of time the child partook in moderate to vigorous physical activity and the estimated energy rates of the children were determined for each 30 minute observation period. The direct observations showed that the children spent 74.5% of the time at home being sedentary (partaking in activities such as indulging in media or eatting food). While the children were outdoors, their engagement in moderate to vigorous physical activity increased, in contrast MVPA was reduced when children were indoors and watching media. Being outdoors created many more prompts to engage in activity (28%) and being indoors (11%). And while outdoors, not only are they receiving more prompts, but the majority of the prompts were for beign more active (26%), than for being sedentary (2%). Conversly, while inside they recived less total prompts, but when propted to do an activity it was more likely to be sedentary (8%) than active (3%).

According to the research, the actual location of the child, and whether they were viewing media were two influencial factors in determining the variance in the amount of MVPA acquired. When children were indoors, the majority of parents prompts tended to promote sedentary behavior (85% in boys, and 65% in girls).

The findings of this study not only supported the beliefs of the researchers that at-home environmental variables act as barriers to physical activity within the adolescent population, but also the belief that outdoor time increases the amount of physical activity. However, there are limitations that are associated with the study. The limitations include a small sample size that was limited to Mexican-American children that lived in 13 communities in Southern California. In addition to the small sample, the use of the direct observation hindered the ability to collect sufficient data being that each child was only observed for an hour total. The final limitation within the study is stated to be the possible adjustment of attitude and behavior on behalf of the children and the parents during the period(s) of observation (McKenzie et al., 2008).

There are few youth that meet the 60-minute minimum requirement of moderate to vigorous physical activity per day. This lack of MVPA is attributed various factors including; built environment, increased prevalence of technology, i.e. gaming consoles and handheld devices, and the overall decrease in the amount of time spent outdoors (Schaefer et al., 2014). With the prevalence of outdoor activity on a decline, it is important to determine the correlation between outdoor exposure and increased physical activity. To do so, a study of 306 youth, aged $13.6 \pm 1.4$ years who were previously involved in the Healthy Hearts Prospective Cohort Study of Physical Activity and Cardiometabolic Health study in 2009, were asked to participate in a study that used a

self-reported questionnaire and an accelerometer to assess their levels of physical activity and the location of the activity itself. The questionnaire itself was a web-based questionnaire that was intended to assess self-reported health behaviors and time spent outdoors  for the past 7 days. The questions had 3 possible response; none, some, and most of the time. With the completion of the questionnaire, the students were then assigned an Actical, serial nos. B101270- B101375 accelerometer to track all physical activity in which the youth engaged in. When the participants were given the accelerometers, they were instructed to wear it for a period of 7 days, ensuring a minimum of 3 days of data collection. To ensure sufficient data, the individuals who failed to complete 3 days of data were excluded from the results upon completion of the study.

After the seven day period for data completion, the accelerometers were recollected and the questionnaires were assessed. The results of the questionnaire are as follows; 17% of participants reported spending no time outdoors, 44% reported spending some time outdoors, and 39% reported to spending all/most of their time outdoors. Through the analysis of the data collected accelerometers, it was concluded that only 34% of the participants were able to complete the minimum of 60 minutes of MVPA per day. In order to determine whether or not the time in which an individual spends outdoors has an impact on their level of physical activity, the three categories from the questionnaire; none, some, and most of the time, were placed against one another and compared the amount of physical activity accured. Through the analysis of this comparison, it is clear to see that the individuals that reported higher levels of outdoor exposure and play also displayed higher levels of physical activity with the acceleromter.

On average, the individuals that reported no outdoor time only completed $39.9 \pm 19.1$ minutes per day of physical activity, those who reported some time outdoors completed $52.7 \pm 23.0$ minutes per day, and the participants that reported spending most of their time outdoors completed $66.5 \pm 29.7$ minutes of physical activity per day. To further the comparison, it is stated that those who reported spending most of their time outdoors spent on average 57% more time engaged in MVPA than those who reported spending no time outdoors.

Through the data that was collected and presented, the researchers were able conclude that outdoor time is a direct correlate to time engaged in physical activity. However, there are various limitation within the study itself that need to be taken into consideration. The first limitation is the susceptibility of a possible skew due to the self-reported nature of the questionnaire. In addition to the questionnaire, the amount of useable data that was received from the participants had the potential to skew the data as well. The researchers stated that only 52% of the participants that initially engaged in the project reported data that was sufficient enough for use (Schaefer et al., 2014).

Through various studies it has been proven that there are indeed various correlates that either hinder or contribute to the physical activity in which an individual partakes, however, within these findings, there are various conflictions(Sallis, Prochaska, & Taylor, 1999). In order to determine the validity of the associations and or correlates of physical activity within children and adolescents, 108 journals that assessed a total of 88 variables of physical activity were evaluated. The variables that were assessed ranged from sex, physical activity preferences, intentions of being active, barriers, and the amount of time that is spent outdoors. Upon selection of the studies, the variables were

placed into one of the six categories: demographic/biological, psychological/cognitive/ emotional, behaviorial attributes/skills, social/cultural factors, and physical environment. To manage the amount of variables/correlates, the variables that were not mentioned in at least three sources were excluded from the study. Within the studies themselves, the sample sizes had a mean of $321 \pm 367$ , and approximately 60% of all associations or correlates were proven to be statistically significant.

Upon the categorization and ranking of the associations and correlates, it was founded that environment was a consistent correlate that showed a positive correlation in regards to the physical activity within the children of the study. More specifically, access to recreational facilities/programs and the amount of time that a child spent outdoors were among the most prevalent. These findings within the review go to further support the clause that time spent outdoors is in fact a positive correlate of time engaged in physical activity. However, there are various limitations that are associated with the review itself. It is noted that the diverse nature of the articles reviewed; variables, measures, samples, prevented the implementation of a true meta-analysis of the results and or categories of correlates. In addition to the wide range of variables, the possibility of a bias within the reporting of the studies, eliminating negative findings/correlations, may have also had an impact on the results of the review in general (Sallis et al., 1999).

Even though there is an insurmountable amount of evidence that point to the correlation between physical activivity and the ability to be protected from illnesses, there is little understanding of the correlates of physical activity among children (Baranowski, Thompson, DuRant, Baranowski, & Puhl, 1993). In previous studies, it has been seen that children display a higher level of physical activity when they are outdoors

than was displayed when the children were indoors, however, there needs to be further research done within the spectrum of correlates of physical activity within the child population, while there is some supporting evidence of certain correlates, there needs to be more verification/validation for these results to be definite. In order to do so, a studied focused on diet, physical activity, and cardiovascular disease (CD) was conducted in Galveston, Texas on 191 three or four year old children that were of three ethnicities (African-America, Anglo-American, and Mexican-American). The study consisted of direct observations during play and meal time. The observations took place no more than 4 times per year over a span of 3 consecutive years. During observation of play, the childrens movements were scored 1-5, 1 being stationary and 5 being fast trunk movement, for every minute that the observation lasted. The observer made sure to note any changes within the level of physical activity within the minute of observation. During the span of observation, the location of the activities that the child engaged in was also recorded. The physical activity was placed into a location category of; eating area in home, kitchen, inside home general, school playground, outside general, etc. For the purposes of the study, during the analysis of the data, the time spent outdoors was compared through the use of an ANOVA rather than comparing all of the locations due to the lack of observations in each location.

Through the analysis of the data, it is seen that the majority of the time spent active within the sample was observed either inside the home, at play-school, or outside (playground or general). While the majority of the childrens' time was spent indoors; 61,043 minutes was the total minutes spent inside the home for all females in the study, compared to females spending a total of 13,837 minutes outside, it was noted that the

children partook in greater levels of physical activity when they were exposed to outdoor environments rather than being indoors. This is supported through the analysis of the mean activity times within the sample. This was consistent in boys (average physical activity score inside 1.89 versus outside 2.34) and girls (average physical activity score inside 1.93 versus outside 2.37) and across every month of the year. In January, females had a mean activity score of $1.85 \pm 0.21$ while indoors and a mean activity score of $2.51 \pm 0.49$ when outside. A higher score indicates more phycial activity. Even though the study is able to support the clause that outdoor time is a positive correlate of physical activity, there are a few limitations that are present in the study. The self-report of the observations can prove to cause a slight skew within the data that was presented. In addition to the observation reports, the naturalistic nature of the study may have proven to be disadvantageous to the children and the physical activity that they partook in. According to the researchers, it would be more beneficial to the study to introduce the children to particular physical activity setting, indoor vs. outdoor, to better gauge the difference between the two (Baranowski et al., 1993).

While there is much to learn still in regards to the correlates of physical activity within children, most researchers agree that physical activity within the youth population is much lower than recommended (Klesges, Eck, Hanson, Haddock, & Klesges, 1990). There is a vast array of health benefits that coincide with an individual being physically active, however, with the large number of youth being inactive, it is important to understand correlates or reasons behind physical inactivity or activity. One aspect of physical activity that reserchers have begun to shine light on is the environment of the activity that the child is partaking in. The aim of the research is to determine whether or

not there is any affect on the amount of physical activity that a child is getting in response to location, more specifically, whether indoor or outdoor time promotes engagement in physical activity. In order to determine the relationship between location and physical activity, 222 participants (122 boys and 100 girls) with a mean age of $4.44 \pm 0.50$ , were recruited from various pediatricians and day-care centers to partake in the study.

During the span of the study, each child underwent a one hour at-home observation period. The observers used and followed the Studies of Children's Activity and Nutrition (1986) Children's Activity Timesampling Survey (SCAN CATS) guidelines for observations. Each observation took place during the afternoon/early evenings, but not during any time that the child would be restricted from going outdoors (stormy weather, too late at night). During the one hour observation period, the observer would watch the child for approximately 10 seconds then take 10 seconds to record the location, intensity, and nature of the activity that the child is engaged in. The observations spanned over a 7-month time period.

Upon completion of the 7-month observational period, a hierarchial linear-regression analysis was used to evaluate the relationship between various factors and physical activity time. It was through this analysis that the very strong positive correlation was found between physical activity and the amount of time spent outdoors; $\text{standardized } \beta = .34, p < .001$. Furthermore, with the increase in the amount of time that a child was observed outdoors, the higher the amount of physical activity that the child partook in. It is further stated that the results of the children being more active outdoors is not one that is surprising, it is believed that this correlation comes from the simple fact that the indoor environment of the home is not one that is considered

conducive in the promotion of physical activity. While the study was able to confirm the correlation between outdoor time and physical activity, there are several cautions that are mentioned through the study. The first is the self-reported nature of the observation process, an individual may misiniterpret the level of physical activity and further skew the data. The second limitation that is mentioned within the research is the socioeconomic status of the participants chosen to participate in the study. It is noted that there is little diversity within socioeconomic standings with all of their participants coming from the upper-middle class (Klesges et al., 1990).

With physical inactivity being ranked the fourth mortality risk globally, it is imperative to society's wellbeing to successfully identify the correlates of physical activity to further reduce the diseases that are seen within our physically inactive society (Solomon, Rees, Ukoumunne, Metcalf, & Hillsdon, 2013). In order to determine the correlates of physical activity, 128 rural villages throughout Devon, south-west England were recruited to partake in the study. Each of the villages had a population that ranged from 500-2000 inhabitants. To gather the appropriate information on the participants physical activity tendencies, each household was sent a short version of the International Physical Activity Questionnaire (IPAQ-SV) that consisted of 28 questions designed to gauge the level of physical activity for each participants, along with the location of the activities that they partook in within the past seven days. The activities were categorized into one of the following; vigorous-intensity activity, moderate-intensity activity, walking and sitting behaviors . In addition to the questionnaire, the participants were also asked to categorize the amount of physical activity that they engage in on a regular basis and were then categorized on whether or not they met the United Kingdom physical activity

requirements of 150 minutes per week. Within the questionnaire, the participants were also asked about their tendencies to use outside facilities and the availiability to these facilities as well.

Upon completion of the questionnaire period, 2,415 participants returned the survey, the participants were mainly female and had a mean age of $58 \pm 15.2$ $(SD)$ years. With the questionnaires returned, a multilevel logistic regression was used to determine whether environmental, social, and personal factors are associated with the level of physical activity that was accrued. Through the analysis of the questionnaires received back, the two prominent correlates found within the environment portion of the study was the availability of man-made sports facilities and individuals who are dog owners. It is shown that individuals that own dogs are close to 95% more likely to meet the physical activity requirements of 150 minutes per week in comparison to those that do not own dogs. This increase in the likeliness of gaining physical activity is seen through the implementation of park and walk time with the dogs. The main limitation that is seen within this study is the use of the self-reported questionnaire, with the self-reported portion of this research, it is possible that this may lead to dishonesty which may ultimately skew the data in any way (Solomon et al., 2013).

# CHAPTER III

# METHODS

*Participants*

This study recruited 25 Maryville College students, ranging in age, class standing, degree, gender, and physical activity behaviors. The study took place during the months of September to December of 2016. A group of Mountain Challenge student employees and a sample of students who were not non-Mountain Challenge employees were recruited to participate in this study. The process of recruitment for this study consisted of email invitations via Today@MC services, facilitators of the study conducting in-class visits, and visiting Mountain Challenge staff meetings to inform students of the purpose of the study and invite their participation in the study. The eligibility criteria of the study included being a non-athlete Maryville College student. Students who were Maryville College athletes in season were excluded due to the likelihood of increased participation in MVPA throughout practice and competition, which could skew the final results.

The 25 Maryville College students who participated in this study, were classified into two groups: (1) Maryville College students who were employees of the Mountain Challenge program (Mountain Challenge employees: n=13); and (2) students who were not employed by the Mountain Challenge and not on an in season athletic team (non-Mountain Challenge employees: n= 12). The Mountain Challenge employees aim to

engage the student body in outdoor physical activity on a regular basis, and therefore may be more likely to be engaging in outdoor physical activity themselves.

*Instrumentation*

Throughout the study there were various instruments that were implemented to ensure success in valid and accurate measures. One of the instruments that used within the study was the ActiGraph GT3X accelerometer. The ActiGraph was used in the study to measure the movement of the participant, more specifically, the acceleration of the movement in which the participant underwent. The ActiGraph is a widely used tool in the realm of PA measurement and has been proven to be a valid and reliable device when measuring PA through a study performed with children (O'Neil, Fragala-Pinkham, Forman, & Trost, 2014). As mentioned, the ActiGraph is a measurement device that is used to determine the physical activity of the individual that is wearing the device. Throughout the use of the ActiGraph, the device is recording the duration of activity in a unit of counts. According to ActiGraph, a count is a measurement of movement that is calculated when the displacement, velocity, and acceleration of the movement are taken into consideration. (ActiGraph, 2015) Counts are generated each hour and classified into sedentary (0-99 counts), light (100-759 counts), lifestyle (760-2019 counts), and MVPA (≥2020 counts). (Troiano et al., 2008)

Another measurement device that was implemented to collect data on movement is the Omron HJ-325 pedometer. The pedometer was used in the study to count and keep track of the number of steps that the participant took each day of the study. The Omron HJ-325 pedometer is a piezoelectric device, meaning that it measures acceleration during time intervals. The validity and reliability of the Omron HJ-325 device is proven through

a study that examined another piezoelectric device. The study had sixty participants partake in PA on a treadmill while wearing the Omron HJ-303. The participants were to wear the device in either the right pocket or attached to the right hip and perform PA at a specific intensity. It was found within the study that the Omron device was a valid means of measuring steps when worn on the waist (Steeves et al., 2011). Per the Omron instruction maual, in addition to the ability of obtaining the number of steps that the individual took in the day, the Omron device is also capable of determining the amount of steps taken that fall into the category of aerobic exercise and the amount of calories burned by the participant as well (Omron, 2014).

Another means of data collection and measurement is the International Physical Activity Questionnaire, or the IPAQ. The version of the IPAQ that was used in this particular study was the IPAQ-s, or the IPAQ-short. The IPAQ consisted of seven questions that were designed to measure the current physical activity, or sedentary, behaviors of the participants by asking about the amount of time spent engaged in PA and the amount time the participant is engaging in sedentary behaviors (Table. 1). Outcome variables from the IPAC included the average number of days the participant partook in vigorous and moderate PA, the duration of the PA, and the number of days the participant walks for more than ten minutes during a normal week.

Table 1: Questions from the IPAQ administered to participants within the Fit Green Happy Study

| | |
|---|---|
| How many ***days*** in a usual week do you do ***vigorous activities*** for at least 10 minutes at a time, such as running, aerobics, heavy yard work, heavy lifting, aerobics, fast bicycling or anything else that causes a large increase in your breathing or heart rate? | ❍ 0* ❍ 4<br>❍ 1 ❍ 5<br>❍ 2 ❍ 6<br>❍ 3 ❍ 7<br>***→ If "0" Skip the next question.** |
| On days when you do ***vigorous activities*** for at least 10 minutes at a time, how much ***total time (minutes)*** each day do you spend doing these activities? | ___ minutes (10-120 minutes)<br>❍ I do not do vigorous activities for at least 10 minutes at a time |
| How many ***days*** in a usual week do you do ***moderate activities*** for at least 10 minutes at a time, such as carrying light loads, bicycling at a regular pace, double tennis, vacuuming, gardening, or anything else that causes a small increase in your breathing or heart rate (Do not include walking)? | ❍ 0 ❍ 4<br>❍ 1 ❍ 5<br>❍ 2 ❍ 6<br>❍ 3 ❍ 7<br>***→ If "0" Skip the next question.** |
| On days when you do ***moderate activities*** for at least 10 minutes at a time, how much ***total time (minutes)*** each day do you spend doing these activities (Do not include walking)? | _____ minutes (10-120 minutes)<br>❍ I do not do moderate activities for at least 10 minutes at a time |
| How many ***days*** in a usual week do you **walk** for at least 10 minutes at a time, such as walking at work/school and at home, walking to travel from place to place, and any other walking you would do solely for recreation, sport, exercise, or leisure? | ❍ 0 ❍ 4<br>❍ 1 ❍ 5<br>❍ 2 ❍ 6<br>❍ 3 ❍ 7<br>***→ If "0" Skip the next question.** |
| On days when you do ***walk*** for at least 10 minutes at a time, how much ***total time (minutes)*** each day do you spend **walking**? | _____ minutes (10-120 minutes)<br>❍ I do not do **walk** for at least 10 minutes at a time |

The final tool that was implemented within this study for the purposes of data collection was a daily physical activity log to supplement and inform the use of the objective monitors. In this study, the participants were asked to log any intentional or planned physical activity that they partook in throughout their day for the seven-day experimental period. In addition to logging the physical activity throughout the day, the participants were also instructed to log the times in which the elastic belt, which contained the ActiGraph and Omron, was removed and the reasoning behind the removal. While the Omron HJ-325 has a ten-day internal storage, the participants were to log the number of steps that were taken during the day. By having the participant log the nature

of the physical activity, the times that the devices were removed, and the steps that were taken, we are then able to infer whether the activity occurred indoors or outdoors and explore patterns of sedentary/active behaviors.

*Procedures*

During the month of October of 2016, recruitment for the study commenced. The recruitment for the study was conducted using two separate methods. The first step for recruitment was through emails sent out via Today@MC services. Today@MC is an email based newsletter that is sent daily to every student and faculty member at Maryville College. Within these email announcements, a brief description of the study was given along with an invitation to become a participant of the study. In addition to the email services, facilitators of the study partook in in-class visits. While in the classroom, a description of the study and the purpose behind the study was presented to the students.

To initiate the data collection period with all participants, a meeting date and time was established. Upon arrival to the meeting, the participants were read the informed consent form which stated the overall purpose of the study, the expectations of the participants, and the risks, if any, that are involved with the study. If in agreeance to participate, the participants then signed and returned the informed consent form.

The height of the participants was determined using a pre-measured distance on a door sill, and to determine the weight of the participants, a Befour Inc. model FS0900 scale was used to accurately obtain the weight. To properly initiate the Omron pedometers, the participants were asked to take ten paces, at normal stride, on a pre-measured distance. Once the participants took the appropriate amount of steps, the facilitators then divided the distance walked by ten to get the average length of each

stride. With the height and weight of the participant collected, the pedometer, Omron HJ-325 was initiated and calibrated with the height and weight of the participant. To do so, the facilitator pressed and held the home button on the pedometer for three seconds, or until the display on the screen began to blink. Using the up and down buttons, the height of the participant was entered, using feet and inches. Once entered, the facilitator then hit the enter button to move to the next screen to enter the weight of the participant, in pounds. In addition to the calibration of the height and weight of the participants, the calculated stride length of the participant was also entered into the pedometer, the time was also set to ensure the pedometer was storing data for the correct twenty-four-hour period. Upon completion of the calibration of the Omron, the facilitator then hit the enter button until the home screen, step count, was displayed. A brief explanation and demonstration about the use of the pedometer was given to the participants. The demonstration included showing the participants how to access the internal storage of the device to view the step count from previous days. In addition to the Omron HJ-325, the ActiGraph GT3X was also used in the study. However; the ActiGraph was fully charged and initiated in the head facilitators office.

Upon the completion of the calibration and initialization of the devices, both, the Omron and the Actigraph, were placed on an elastic belt for wear around the waist with both monitors situated at the right hip. Before the participant was given the elastic band containing the devices, the identification code on the back of the Omron was logged into the data collection sheet. This code was now used as the identity of the participant throughout the study. The facilitator then demonstrated to the participant the proper wear location for the band, around the waist with monitors at the right hip, and the protocols

for wearing the devices. The participants were informed that the elastic band containing the devices must be taken off before engaging in any activities with rough contact or contact with any source of water, other than sweat, and before the participant went to sleep. After receiving the measurement devices, the participant was then assigned an activity log that was previously coded with their identification number. The participant was walked through the use of the activity log data collection sheet: instructed to date the sheet according to the seven-day study period, log the time the devices were put on upon waking up, log any planned/intentional physical activity and a description of the activity, and any time that the devices were removed throughout the day, noting the reasoning of removal. Before leaving the meeting, the participants were asked to schedule a date and time to return the devices and activity log. During the second meeting, the participants completely the IPAQ survey. Also, the facilitators looked over the activity log and if any discrepancies were found within the log, the participants were asked to further explain and clarify.

Upon the completion of the follow-up meeting, the devices and activity logs were then brought to the office of the head facilitator, Dr. Jeremy Steeves, and the data was compiled on a secure database.

Independent variables:

Within the study, there are various independent variables that are worthy of identifying. The independent variables of the study are found within the demographical portion of the survey completed by the participants. The variables that were assessed were the gender, age, height and the weight of the participant.

Dependent Variables:

The dependent variables within the study are the outcome measures that were measured from the accelerometer, the pedometer, and the IPAQ. These variables include the steps taken during the week of the study, the intensity of the exercise; sedentary, light, lifestyle, or MVPA (determined via counts measured), and the duration of time in which the activity took place.

*Statistical Analysis*

Data analysis was conducted through the SPSS software, a statistical software program. The data that was collected was analyzed through the implementation of independent sample t-tests, which were used to compare continuous physical activity variables between the Mountain Challenge and Regular Students; such as the difference between the amount of time engaged in MVPA, the number of steps taken per day, and various other variables that were collected via the use of the IPAQ, ActiGraph, and Omron pedometer. Chi square tests were used to determine the difference between categorical measured variables between the Mountain Challenge employees and non-Mountain Challenge employees. The categorical variables that are seen within this study are whether the participant is a Mountain Challenge Student or a Regular Student, and if the participant is either male or female.

# CHAPTER IV.

# RESULTS

The descriptive statistics of both Mountain Challenge Students (n=15) and the Regular Students (n=9) are presented in Table 1. On average, the Mountain Challenge students were aged 19.73 ± 1.44 years of age and the Regular students 20.11 ± 0.93 years of age. The average height of the Mountain Challenge students was 1.69 ± 0.12 meters while the Regular students measured on average 1.72 ± 0.13 meters in height. The weight of the Mountain Challenge students was 70.64 ± 16.95 kg on average and 73.08 ± 15.13 kg for the regular students. On average, the Mountain Challenge students had a BMI of 24.52 ± 3.94 $kg/m^2$ and the Regular students had a BMI of 24.45 ± 2.71 $kg/m^2$. It is also noted that 66.70% of the population studied were female participants.

Table 1. Baseline Characteristics of Study Population (n = 24)

| | Total (n=24) | Mountain Challenge Students (n=15) | Regular Students (n=9) | P value |
|---|---|---|---|---|
| Age (years) M (SD) | 19.88 ± 1.26 | 19.73 ± 1.44 | 20.11 ± 0.93 | 0.49 |
| Height (m) M (SD) | 1.70 ± 0.12 | 1.69 ± 0.12 | 1.72 ± 0.13 | 0.56 |
| Weight (kg) M (SD) | 71.56 ± 15.99 | 70.64 ± 16.95 | 73.08 ± 15.13 | 0.73 |
| BMI ($kg/m^2$) M (SD) | 24.50 ± 3.46 | 24.52 ± 3.94 | 24.45 ± 2.71 | 0.96 |
| Female (%) | 66.70% | 66.70% | 66.70% | 0.68 |

Mountain Challenge students self-reported greater amounts of weekly MVPA (913.67 ± 369.05 minutes) compared to Regular students (644.22 ± 373.99 minutes), however this difference did not reach statistical significance (p = 0.09) (Table 2).

Table 2. Comparison of Mountain Challenge students and Regular students on self-reported and objectively measured physical activity-related variables (n = 24)

| | n | Mountain Challenge Students (n=15) | Regular Students (n=9) | P value |
|---|---|---|---|---|
| IPAQ reported Weekly MVPA M (SD) | 24 | 913.67 ± 369.05 | 644.22 ± 373.99 | 0.09 |
| Number of Regular Physical Activities M (SD) | 24 | 3.13 ± 1.41 | 2.22 ± 0.83 | 0.09 |
| Number of Regular Outdoor Activities M (SD) | 24 | 2.53 ± 1.36 | 1.00 ± 0.50 | **0.004** |
| Percentage of Regular Outdoor Activities M (SD) | 23 | 84.40 ± 40.08 | 50.00 ± 25.00 | **0.03** |
| ActiGraph Measured MVPA (daily %) | 21 | 7.50% ± 3.29% | 4.68% ± 1.64% | **0.047** |
| ActiGraph Measured MVPA Minutes | 21 | 54.21 ± 22.12 | 34.86 ± 12.29 | **0.046** |
| Self-reported TV Minutes/Day | 24 | 63.63 ± 67.77 | 43.13 ± 56.05 | 0.45 |
| Self-reported Minutes of Physical Activity/Day | 24 | 69.15 ± 62.34 | 23.81 ± 38.37 | 0.063 |
| Omron measured Steps/Day | 24 | 8552 ± 3910 | 4622 ± 3518 | **0.022** |

The percentage of outdoor activities that Mountain Challenge students reported engaging in (84.40 ± 40.08) was significantly greater than the Regular students (50.00 ± 25.00, p = 0.03). Additionally, data collected via the ActiGraph shows that the Mountain Challenge students partook in significantly more minutes of MVPA per day (54.21 ± 22.12) than the Regular students (34.86 ± 12.29, p = 0.046) (Figure 1).

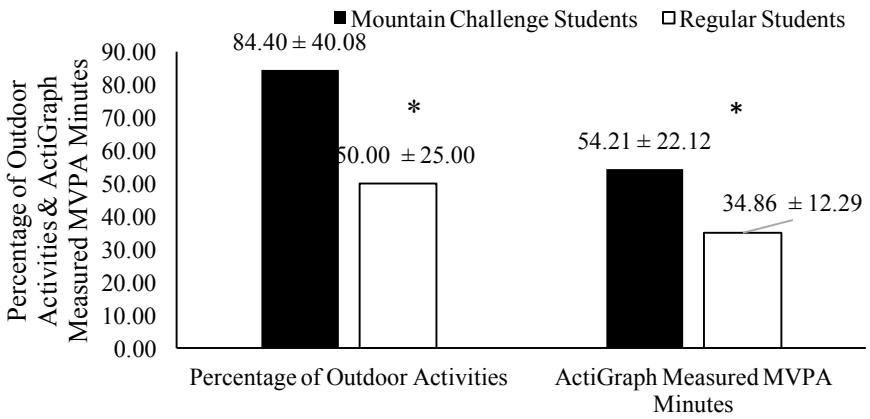


**Figure 1.** Percentage of Outdoor Activities and Actigraph Measured MVPA Minutes. * Significant difference between Mountain Challenge students and Regular students.

Further analysis showed that the Mountain Challenge students also spent a significantly greater percentage of time per day in MVPA (7.5 ± 3.3%) compared to the Regular students (4.7 ± 1.6%, p = 0.047). Additionally, the number of outdoor activities that Mountain Challenge students engaged in (2.53 ± 1.36) was significantly greater than the Regular students (1.00 ± 0.50, p = 0.004) (Figure 2).

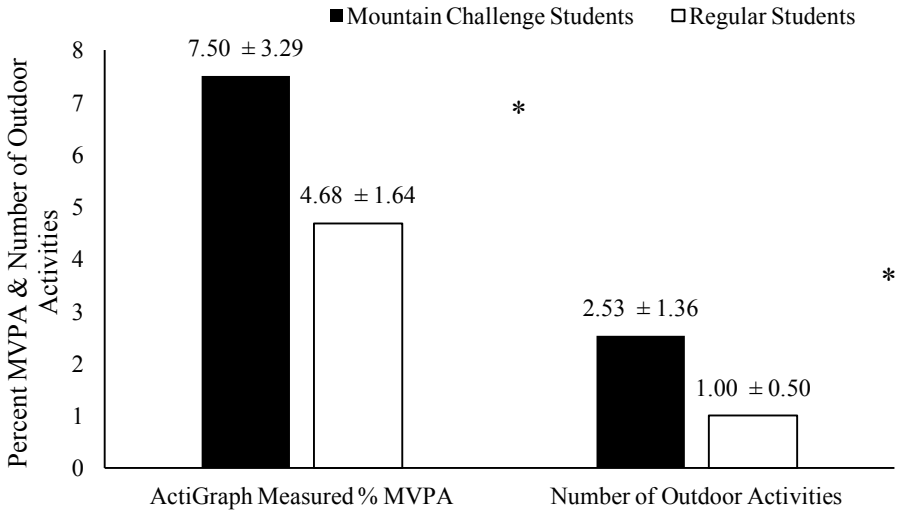


**Figure 2.** Percent MVPA (measured via ActiGraph), and Number of Regular Outdoor Activities. * Significant differences between Mountain Challenge students and Regular students.

The final variable that was analyzed was the steps per day taken between the two groups, Mountain Challenge and Regular students. This data was collected via the use of the Omron pedometer, and shows that the Mountain Challenge students (8552 ± 3910) took significantly more steps than the Regular students (4622 ± 3518, p = 0.022) (Figure 3).

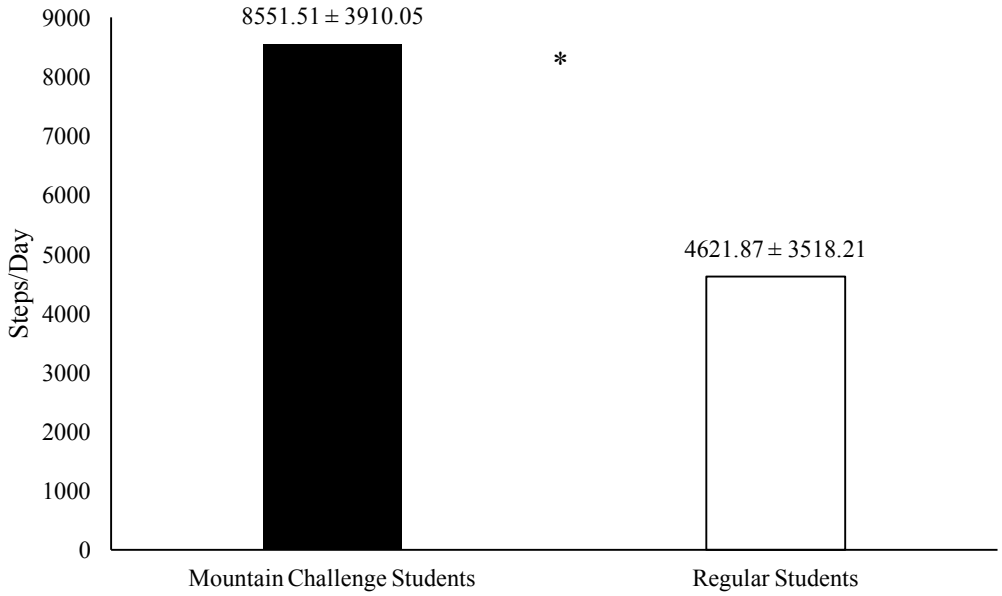


**Figure 3.** Steps taken per day, collected through the use of the Omron pedometer. * Significant differences between Mountain Challenge students and Regular students.

# CHAPTER V.

## DISCUSSION

The purpose of this study was to measure the physical activity levels of Mountain Challenge student employees and a group of non-Mountain Challenge Maryville College students to determine whether or not there are any differences in total physical activity levels, or participation in outdoor physical activity between those students who work and likely play outdoors a lot to students who may not work and play outdoors. The Maryville College students that were employed by the Mountain Challenge program, a community outreach program aimed to increase sustainability and outdoor involvement, spent more time outdoors, whether it be work or play related, and engaged in more physical activity than the Regular students. Additionally, there were indeed significant differences between Mountain Challenge Students and non-Mountain Challenge Students using both objectives measures of physical activity' accelerometer and pedometer. These objective measures of physical activity showed that the students involved with the Mountain Challenge program obtained greater levels of physical activity than the students that are not involved with Mountain Challenge. Specifically Mountain Challenge Students had greater steps per day, minutes of MVPA, and a greater percentage of their day was spent in MVPA, and they reported a larger number anf greater percentage of regular outdoor activities, which are believed to be the leading determinant in the greater levels of physical activity seen in the Mountain Challenge Students. Some previous research has

focused on physical activity in youth and young adults and in those who may spend more time outdoors can be compared to our study on the physical activity levels of the students on a college campus.

Previous research using similar devices as the ones in our study compared the levels of physical activity that one gets in relation to the location where the physical activity was engaged in. Of the 100 children that were observed, the children that were able to participate in outdoor activity averaged approximately 5 more minutes of moderate to vigorous physical activity than the children that were not granted access to outdoor time and activities. Similar to our study, the children's activity was monitored through the use of an accelerometer, which was paired with GPS to determine the location of the physical activity. Through the analysis and comparison of the data collected thought out the study, the researchers concluded that the location of where the physical activity was engaged in played a major role in the overall amount of physical activity that the child obtained, with outside activity providing greater amounts of moderate to vigorous physical activity (Jones, Coombes, Griffin, & van Slujis, 2009).

Our study was based on the hypothesis that spending more time outdoors may lead to the increase in levels of physical activity. Previously, researchers have used an individual's occupational category to assess the prevalence of physical activity within the workplace for the adult population. It was found within this study that those who hold more blue collared, or more labor intensive occupations, are engaged in more physical activity throughout the day than white collared occupations (Steeves, et al., 2015). Additionally, the jobs that were likely primarily outdoors like farmers, nursery workers, and construction occupations were among the highest-ranking occupations for greater

daily physical activity. When comparing the amount of time that the individuals spent engaged in moderate to vigorous physical activity, it was found that farmers, along with other agricultural occupations, had the highest TAC, total activity count, and accumulated the greatest amounts the moderate to vigorous physical activity (~8%) (Steeves, et al., 2015). In contrast, occupations that consisted of less outdoor exposure; scientist, engineer, etc., had the lowest TAC, lower amounts of moderate to vigorous physical activity (~3%), and the highest time spent in SB, sedentary behavior (40%) (Steeves, et al., 2015). These results go to further the belief that the occupation that one holds impacts the amount of physical activity that they are able to engage in on a daily basis (Steeves, et al., 2015). This comparison of occupations is also seen directly between the Mountain Challenge Students and the non-Mountain Challenge Students. In our case, the Mountain Challenge Students are employed through the Maryville College Mountain Challenge Program and are responsible for facilitating outdoor activities and trips for student's campus wide. With that said, the Mountain Challenge Students are in essence a representation of the blue-collar workers, displaying higher levels of moderate to vigorous physical activity (~8%) in response to the demands the Mountain Challenge Program places on them, while the non-Mountain Challenge Students would more likely identify with those who hold more sedentary occupations (~5% of daily activity was moderate to vigorous physical activity).

With the pedometer and the accelerometer being the primary sources of objective data, the reliability and accuracy of the devices come into play greatly. Previous research has found that the Omron HJ-303 tri-axial accelerometer-based pedometer is highly accurate (Steeves et al., 2011). While we used a cousin of the Omron HJ-303, the Omron

HJ-325, in our study, it has the same internal mechanism for step detection so it can be assumed that the reliability and accuracy of the device will reflect that of the Omron HJ-303.

In 2004, the concept of a graduated step index for healthy adults was introduced. This index is a means to categorize an individual's physical activity by the number of steps that they take throughout the day. The guidelines of this index state that when an individual takes: less than 5,000 steps/day they are sedentary, 5,000-7,499 steps/day are low active, 7,5000-9,999 steps/day somewhat active, 10,000-12,499 steps/day are active, and greater than 12,500 steps/day are highly active (Tudor-Locke, et.al, 2011). Looking at the data that was collected through our observation period it is seen that the Mountain Challenge Students averaged $8551.51 \pm 3910.5$ steps/day, which places them in the somewhat active category. The non-Mountain Challenge Students averaged only $4621.87 \pm 3518.21$ steps/day, which places them in the sedentary category, according to their steps/day.

While it was found within our study that the Mountain Challenge students did engage in a greater percentage of their physical activity outdoors, and had a greater number of the activities that they engaged in outdoors, there was no significant difference when it came to the comparison of the total activities engaged in between the Mountain Challenge Students and the non-Mountain Challenge Students. With our study being one of the first to analyze the differences in physical activity in college age individuals, it is difficult to support our findings. However, a previous study attempted to examine the determinants of physical activity within college students and discovered that 30 to 50% of all college students do not participate in the adequate amount of physical activity to be

healthy (Keating et al., 2005). It was further found that the environment that the students have access to plays a vital role in the not only the amount but the type of physical activity that they are able to engage in (Keating et al., 2005). With the unpredictable schedule of college students, it may be unfavorable for the typical college student to spend a considerable amount of time outdoors being active. It may be more typical for students to go to an indoor facility and engaging in physical activity there. The combination of an unpredictable schedule and lack of access to outdoor activities during times available is seen clearly through the results of our study. The Mountain Challenge Students, who facilitate the outdoor activities, were more active and spend more time engaged in outdoor activities, however; non-Mountain Challenge Students, unpredictable schedule, and not having a job that mandated that they be outside may have led to the decrease in outdoor time availability and physical activity.

Knowing that time spent outdoors is beneficial to health, both physiologically and psychologically, may be a driving force to promote and encourage college students to obtain more physical activity outside. The benefits of partaking in the adequate amount of physical activity include the lowering risk for cardiovascular disease, type 2 diabetes, and hypertension, along with increasing the overall life expectancy of an individual (U.S. Department of Health & Human Services, 2016). While the health benefits of physical activity, especially outdoors, is important, it is also important to look at the impact of having college student participating in physical activity outdoors from the perspective of sustainability and the overall effect on nature. It is stated in previous research that if further generations do not engage in time outdoors and become disengaged from nature,

then there will be less of an emphasis and importance placed on preserving the beautiful places we have in nature (Gladwell, Brown, Wood, Sandercock, & Barton, 2013).

As discussed earlier, it was found that in our study the Mountain Challenge Students partook in more outdoor activities which may have led to the higher prevalence of objectively measured time in physical activity. Previous research observed the physical activity patterns of 548 children that ranged in age from 5-12 using accelerometers, and had the children record their location of their activities using self-reported logs found that the location of an activity was a direct predictor of the child's activity level. On average, children that were exposed to green environments, and outdoor spaces, obtained 5 more minutes of moderate to vigorous physical activity than the children that were not (Cleland et al., 2008).

Rather than focusing solely on the environment in which the child partook in physical activity, other researchers have explored prompts that encourage children to engage in physical activity rather than remain sedentary (McKenzie et al., 2008). In this study, while at home, the children spent 74.4% of their free time being sedentary, however; when the children were prompted, or encouraged to go outdoors and play, there was a substantial increase in their amount of activity (McKenzie et al., 2008). In addition to being more active outdoors, when indoors, the children were not faced with as many prompts and encouragements to be more physically active (McKenzie et al., 2008).

In addition to the research proposed and completed on the determination of whether indoor or outdoor activity leads to greater levels of physical activity, previous research has explored other determinants of physical activity in. The location of an individual's home or place of residence also can be proven to have an impact on the

physical activity that they are exposed to. It has been shown that those that live in regions that are more urban, therefore lacking green spaces, tend to obtain lower levels of physical activity (Cohen et al., 2014).

Within our study, we found that there were little to no differences with the analysis of the self-report tools, IPAQ and activity logs, however; there were significant differences when the accelerometer and pedometer were introduced to the participants. Similar to our findings, a previous study that resembled ours also attempted to determine the level of moderate to vigorous physical activity in the college population. To do so, the researchers utilized both self-reported logs and an accelerometer. Upon completion of the research, it was found that the participants had reported a significantly higher level of physical activity than the accelerometer had measured (Downs, Van Hoomissen, Lafrenz, Julka, 2014). It is also stated within this study that our tendency to overestimating our levels of physical activity may be contributing to the epidemic of physical inactivity, since many of us may think we are obtaining adequate levels, when according to objective measures we may actually fall short (Downs et al., 2014). To further demonstrate and highlight the differences between physical activity data measured using a self-report and an accelerometer previous research found that almost 51% of the individuals studied reported that they were meeting the 150 minute recommendation for physical activity per week, however, it was found that the prevalence of adherence to the 150 minutes per week of physical activity was less than 5% in the same adult population according to accelerometer measured physical activity (Troiano et al., 2008).. While there is this continual disjunction between self-reported claims of physical activity and the measurements of an accelerometer, another study discusses some causes of this issue

other than the overestimation of physical activity. While the accelerometer is an accurate device for measuring absolute intensity of physical activity, if an individual falls below that threshold the count will not be measured and recorded (Haskell, 2012).

Another interesting finding within our study was the time students spent watching TV. While the Mountain Challenge Students were proven to be more active and spent more time engaged in physical activity outdoors, they consumed relatively the same amount of TV time as the non-Mountain Challenge Students. With the further decrease in the levels of physical activity in our society, the American Academy of Pediatrics has placed guidelines on the amount of time that one should engage in TV per day. Per these standards, an individual should set a limit to an hour a day in front of the television (American Academy of Pediatrics, 2016). With the guidelines for the TV allotted, it is important to note that the population studied here at Maryville College falls within these guidelines for the most part, with the Mountain Challenge Students and the non-Mountain Challenge Students watching 63.63 ± 67.77 and 43.13 ± 56.05 hours of TV per day respectively.

While the overall purpose of this study was to determine whether or not more outdoors time leads to an increase in the amount of physical activity, it also acts as a source of information on this epidemic that our society is facing today. Within the United States alone, less than half of the adults get the recommended daily amount, 30 minutes per day, of physical activity on a daily basis. To further this, only 3 in 10 high school students are meeting this recommendation as well (Carlson et al., 2010; Centers for Disease Control, 2014). It is important to identify the causes of this lack of physical activity, and to understand the negative impact the physical inactivity has on the body.

The prolonged lack of physical activity has been proven to be detrimental to the overall health of the individual and their body. It has been proven throughout time that by engaging in the recommended physical activity, an individual has the ability to control weight, reduce overall risk of: cardiovascular disease, type 2 diabetes/metabolic syndrome, certain cancers, along with strengthening bones and muscles and improving the overall mental health and mood (Centers for Disease Control, 2015).

With the majority of previous research studies focusing and emphasizing on the adolescent and adult populations and the physical activity that those groups are engaged in, it is important to implement research that focuses on correlates and determinants of physical activity in the college age population. However, like all studies there are limitations within this research. The first limitation would be the sample size observed which was small and unequal. The small sample size does not allow us to gain a great insight on the physical activity habits campus wide, rather isolated us to a small subgroup of students. Also, the sample excluded Maryville College athletes from participating. Self-reported logs may be considered a limitation, since using these logs could lead to a skew in the data if individuals reported doing more physical activity than they actually do. Previous research has documented self-reported logs as a source of flaw in studies due to individuals overestimating their levels of physical activity (Downs et al., 2014). The final limitation to consider in this study would be the timing of the observation period(s). In this study, the individuals were not observed at the same time, however; their observational periods were scattered throughout the term of a semester. With this inconsistency in collection period, a number of outside variances, such as weather, exam

schedule, work schedule, etc., could have acted as an interference to the data collection process.

This study shows that a greater amount of time spent outdoors may contribute to an increase in the amount of time that an individual spends engaged in physical activity. This is not only seen through the data that has been collected within this study, which shows that the Mountain Challenge Students who spent more time engaged in outdoor activities were more physically active than the non-Mountain Challenge Students who were not engaged in outdoor activities, but through that of other research. It is through the results found in this study and the knowledge that less than half of adults reach the recommendation for physical activity that we are able to further promote and encourage programs such as Maryville College's Mountain Challenge. It is seen through the data that the program is one that prompts college students to become more physically active through the engagement in outdoor activities. If it were not for the Mountain Challenge program, and other similar programs, there may be a lower prevalence of physical activity on the Maryville College campus. It is important to continue analyzing the physical activity habits of college students to ensure that the appropriate measures are taken to increase the amount of physical activity that college students are engaging in.

With the majority of previous research studies focusing on the adolescent or adult population and the physical activity that they are engaged in, it is important to implement research that focuses on correlates and determinants of physical activity in the college age population. By completing this research, it is important to note the limitations that are associated with the research completed. In this study, the size of the sample studied may have posed as a limitation. With the small sample size, we are unable to get a full

understanding of the physical activity habits of the students at Maryville College. In addition to the size of the sample, the timing of the observation periods also pose as an issue. All of the samples were not observed at the same time, therefore, external issues such as class schedule, exams, work, and weather conditions could have led to either the increase or decrease in physical activity. The final limitation within the study would be the use of self-reported physical activity log.

In conclusion, this study shows that the hypothesis that the exposure to outdoor environments does increase the amount of physical activity that an individual engages in stands true.This conclusion is seen through the data that indicartes that the Mountain Challenge Students spent more time on average outdoors than the non-Mountian Challenge Students, therefore; leading to a higher prevalence of physical activity and supporting the hypothesis of this study.

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