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Effect Of Sedentary And Physical Activities On Children's Food Choice

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EFFECT OF SEDENTARY AND PHYSICAL ACTIVITIES ON CHILDREN'S FOOD CHOICE

by

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Allison Michelle Barry
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ABSTRACT

Background: According to the Centers for Disease Control and Prevention (CDC), approximately 17% of children are obese. Children who are overweight or obese are more likely to become overweight adults. Children's snack choice has shifted from healthy to unhealthy (primarily salty and sweet option), and since children's snack consumption makes up 27% of their total energy intake, it is important to understand influences of their snack choice.

Purpose: To examine the effect of sedentary and physical activities on children's food choice.

Method: Participants included a volunteer sample of children (n=24) ranging from 9-13 years old. Children's height and weight were measured and BMI was calculated using age, height, weight, and gender. Children participated in three conditions. Condition 1 was 60 minutes of sedentary activity (watching movies). Condition 2 was 60 minutes of physical activity. Condition 3 was a mix of sedentary (45 min) and physical (15 min) activities. After each condition, the children were asked to choose one snack from 2 healthy and 2 unhealthy options. The children were randomly placed in groups of four for one of the six possible condition sequences determined by when they enrolled in the study. SPSS was used to assess the data.

Results: Participants had a mean age of 10.6, 13 were male (54.2%) and 19 were normal weight (79.2%) who completed the study. Overall, there was not a statistically significant difference in the overall model comparing the three conditions on snack choice ($p=0.15$). Wilcoxon Signed Rank Post-Hoc analysis showed a trend in children more likely choosing an unhealthy snack option after the SED compared to PA conditions ($p=0.06$). There was not a significant difference between boys and girls for snack choice after any of the PA ($p>0.05$), SED ($p>0.05$), and mixed conditions ($p>0.05$). Overweight/obese children were more likely than normal weight children to choose a healthier snack option after the PA condition ($p=0.02$).

Conclusion: Our findings suggest overweight/obese children tend to choose healthier snack options after a 60 minute bout of PA ($p=0.02$). Promoting physical activity to children who are overweight/obese could potentially lead to losing weight overtime by decreasing energy intake and increasing energy expenditure.

CHAPTER I

INTRODUCTION

According to the Centers for Disease Control and Prevention (CDC), approximately 17% of children and one in three (35.7%) adults are obese (Odgen, Carroll, Curtin, Lam, & Flegal, 2010). The parameters to define obesity in children with a Body Mass Index (BMI) of ≥95th percentile for their height, age, weight, and gender, and for adults is a BMI (kg/m^2) ≥30 (Ogden, Yanovski, Carroll, & Flegal, 2007). Similarly, children who are overweight (85th to <95th percentile) or obese (≥95th percentile) are more likely to become overweight adults (Serdula et al, 1993; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Obesity is a pressing concern for society because of the negative health outcomes and the costs associated with this condition. For example, obese individuals have an increased risk for type II diabetes mellitus, hypertension, cardiovascular disease, and coronary heart disease (Ogden et al, 2007). In 2005, the United States spent an estimated $190 billion on health care for obesity-related care with the average obese person spending roughly $2,741 a year on health costs (Cawley & Meyerhoefer, 2012). Compared to normal weight adults, obese individuals spend $1,429 more in medical costs each year (Finkelstein, Trogdon, Cohen, & Dietz, 2009). Thus, it is important for research to be conducted to examine ways to prevent or reduce childhood obesity

prevalence due to growing evidence suggesting overweight/obese children are more likely to become overweight/obese adults (Serdula et al, 1993; Whitaker et al, 1997).

Obesity is a multi-dimensional disorder and the exact cause is unknown. Researchers have examined factors associated with the increase in childhood obesity, such as genetic, environmental, and modifiable lifestyle factors. With respect to genetic factors, when children are born, they could have a genetic defect causing a problem with the leptin-signaling pathway (Han, Lawlor, & Kimm, 2010). Endocrine disorders such as hypothyroidism, growth hormone deficiency, and Cushing syndrome may also lead to obesity in children. Environmental factors focus on the physical surroundings in which people live. The number of fast food restaurants is growing dramatically in cities compared to 20 years ago (Lin, Guthrie, & Frazao, 1999). It is unknown whether children are more or less active in rural vs urban environments (Martin et al, 2005; Joens-Matre et al, 2008). Modifiable lifestyle behaviors in children include: screen time, diet, and physical activity, which are associated with obesity.

Research suggests that strategies that target modifiable lifestyle behaviors in children can be effective for combating the obesity epidemic (Han et al, 2010). Specifically, understanding child food selection and consumption following sedentary or physically active pursuits may be one strategy towards obesity prevention. When using children as subjects, it is unclear whether or not different activity levels influence energy intake. Some studies have shown sedentary behaviors, such as, increased television (TV) viewing will increase nutrient-dense, nutrient-poor foods (Coon & Tucker, 2002; Gortmarker et al, 1999). In other studies, where children participated in sedentary behaviors and physical activities there was no difference on food intake

(Saunders et al, 2014), similar studies, however, have shown children who participate in physical activities tend to decrease energy intake (Thivel et al, 2011; Bozinoviski et al, 2009).

Modifiable lifestyle factors have changed with people spending more time in sedentary positions (sitting or lying down) and light intensity activity (standing and slow walking) (Owen, Sparling, Healy, Dunstan, & Matthews, 2010). Since the 1970s, jobs have transitioned from high-energy output (construction, manufacturing, farming) to more light activity jobs in 2000 (Brownson, Boehmer, & Luke, 2005). In 2003, 6 in 10 working adults used a computer at work and 9 in 10 children (K-12) use computers at school leading to increased sedentary behavior (US Census Bureau). Another area of concern is in transportation and leisure time where it is estimated that people spend nearly four hours watching TV and one hour in the car per day. In the US, 1 in 4 white Americans spend 70% of their waking hours sitting, 30% in light activity, and hardly any time in exercise. (Owen et al, 2010)

According to the CDC, childhood obesity prevalence in the US has not significantly changed since 2003-2004 with 17% of children being classified as obese, the causes are still unknown, more research is needed to investigate alternate ways to combat obesity (CDC, 2014). There are many modifiable lifestyle behaviors, however, this study focused on sedentary and physical activities, along with food choice. Children consume on average 3 snacks per day, which makes up 27 percent of their calorie intake per day (Piernas & Popkin, 2010). The largest increase in snack consumption has come from children choosing more salty and sweet options instead of healthy options. There has been no research done on examining what influences children to choose healthy

low-calorie, nutrient-dense snacks compared to unhealthy high-calorie, nutrient-poor snacks. There is a gap in the literature on snack choice (healthy vs unhealthy) immediately after exercise and exercise breaks within sedentary behaviors. This study will contribute to the understanding of how to reduce caloric intake in children and decrease obesity.

Purpose

The primary aim is to examine the three conditions on the effect of physical activity and sedentary behavior on children's food choice. The secondary aim examines food choice variation between girls and boys.

Testable Hypothesis

Hypothesis 1

Children will choose a healthier food option following the physically active condition compared to the sedentary condition.

Hypothesis 2

Boys will choose less calorie-dense snacks than girls after all three conditions.

CHAPTER II

LITERATURE REVIEW

While sedentary behaviors have increased, high energy, calorically dense, nutrient poor food consumption has also increased (Lee, 2012). The relationship between sedentary behavior and increased food consumption is one of the many contributing factors to the current obesity epidemic (Han et al, 2010). Researchers have examined the relationship between ethnicity and socioeconomic status and access to healthy and unhealthy food options. In high income areas, there are a greater number of large grocery stores where healthy food options, such as fresh fruits and vegetables, and whole grains, are consistently in stock (Jetter & Cassidy, 2005). These stores also have cheaper healthy food options. Lower income areas consist of convenient stores, small grocery stores and fast food restaurants. Convenient stores stock unhealthier, high energy dense food options that have longer shelf life. The smaller grocery stores have healthy food options, but this option will cost more since the supply and demand is much less (Jetter & Cassidy, 2005). There is a link between socioeconomic status, where a person lives, and what type of food is available. People who live in lower income areas will have greater access to high energy, calorically dense, nutrient poor food options, where as, higher income areas will have easier access and cheaper, healthier food options (Jetter & Cassidy, 2005).

This literature review will examine: causes of obesity; hormone regulation on drive to eat; sedentary and physical activity time; mindful and mindless eating; sedentary effects on child's food choice; and physical activity effects on food.

Causes of Obesity

As obesity rates continue to increase, researchers are examining the multiple causes of obesity. Sedentary behaviors in the work environment and leisure time have shown a strong association with obesity (Owen, 2012). The prolonged lengths of sitting are consistently associated with weight gain in both men and women due to calorie imbalance increasing BMI and waist circumference. People are gaining weight, but there is also an increased risk for all-cause, cardiovascular disease, and all-other cause mortality in men and women (Ogden et al, 2007). Childhood is an important time when sedentary behavior should be limited. Children who partake in sedentary behavior on a regular basis are consistently predicted to be obese and have an increased BMI during adulthood (Ogden et al, 2007). Conventional cardiometabolic risk factors (high blood pressure, glucose, cholesterol) normally found in adults are now being found in children who have excessive sedentary time throughout the day. While people watch TV or play video games, there is an increased consumption of high-energy, low nutrient dense foods (Willimans, Raynor, & Ciccolo, 2008).

According to the Centers for Disease Control and Prevention (CDC), children and adolescents (3-17 years old) should get 60 minutes or more of moderate to intense physical activity every day. Children should not exceed more than 2 hours of TV watching per day (American Academy of Pediatrics, 2001). The more time spent watching TV or remaining in sedentary positions, the greater reduction in physical and

psychosocial health; however, when time is reduced there is a reduction in BMI (Tremblay et al, 2001). Children are now consuming more calories than the recommended daily intake suggests. Boys and girls, 7-10 years old, should consume 2,000 calories per day. Boys and girls, 11-14 years old, should consume 2,500 and 2,200 calories per day, respectively (Lin et al, 1999).

Hormone Regulation on Drive to Eat

There has been an increase in overconsumption of calorically-dense food beyond the nutritional needs of an individual (Berthound, 2006). This overconsumption has been associated with enjoyable feelings of eating, when accumbens-hypothalamus projects might engage the hypothalamic peptidergic systems involved in homeostatic appetite control (Berthoud, 2006). Nucleus accumbens are associated with different parts of the brain, which will release dopamine to affect motivation for work and reward. Hormones, leptin and ghrelin, are associated with appetite, food intake and obesity (Schellekens Finger, Dinan, & Cryan, 2012).

The hypothalamic region of the brain is where the control center of eating behavior is located controlling food drive within the body. The hypothalamus receives and processes signals from different areas of the body allowing it to control homeostasis by adjusting energy intake and energy expenditure. One of the two main hormones involved in the homeostasis cycle is ghrelin. Ghrelin is produced in the stomach and is involved in fasting periods telling the body when it needs to eat. This hormone is found at the beginning of meals and slowly declines by the end of the meal. If there is a ghrelin imbalance within the body it could lead to an increase in signaling the body to consume more food (Popovic, 2006). Leptin is a hormone produced in adipose tissue

and controls satiety levels in the body. When sitting down for a meal, leptin helps to regulate how much food should be consumed (Martins, Morgan, & Truby, 2008).

In the past decade, there have been results from various studies showing that leptin and ghrelin concentration levels can be modified by exercise (Martins et al, 2008; Mackelvie et al, 2007; Kumru et al, 2005). It is important to implement exercise interventions that will improve insulin sensitivity, and in turn, potentially alter leptin levels. The altered leptin levels would be due to changes in fat mass, insulin and cortisol levels. Acute exercise in individuals who have recently eaten does not have an effect on normal weight individuals, unless the exercise goes until exhaustion, which increases plasma leptin concentrations (Martins et al, 2008). When exercise does not allow for any weight loss there is no effect on fasting plasma levels of ghrelin. There are two main branches of ghrelin: acylated and desacyl. Acylated ghrelin is involved in appetite regulations, which can lead to reduction in subjective hunger. Desacyl ghrelin causes a negative energy balance (EB) by reducing food intake and delaying gastric emptying inversely to acylated ghrelin. The effect on acylated ghrelin and desacyl ghrelin plasma levels is due to the duration of exercise, so as the time increases EB becomes more favorable since acylated ghrelin/desacyl ghrelin ratio decreases. This promotes weight loss and helps in weight maintenance (Martins et al, 2008). This could possibly be the reason why there is a short-term appetite control following exercise intervention.

When a person needs to eat, ghrelin is activated to increase the drive to eat, and leptin will tell how much food will be consumed during a meal. If these hormones become unbalanced this could lead to an increased intake in food consumption increasing the chances of people becoming obese (Martins et al, 2008). Exercise could

help alter ghrelin and leptin levels, which is beneficial when trying to lose weight or help maintain weight.

Too Much Sedentary Time vs Physical Activity

Recent findings suggest people do not get enough physical activity during the day to balance the effects and health outcomes of sedentary behaviors (Owen et al, 2010). Sitting for prolonged periods of time reduces the amount of muscle contractions throughout the body that may reduce lipoprotein lipase (LPL) activity, which hydrolyzes triglyceride-rich lipoprotein such as low-density lipoproteins. If LPL activity is decreased, the amount of high-density lipoproteins within the body is also decreased, which is a contributing factor for coronary heart disease (Owen et al, 2010).

Lakerveld and colleagues (2011) looked at how abdominal obesity and TV watching declined leisure time moderate to vigorous intensity exercise in Australians ≥ 25 years old. The data were used from the Australian Diabetes, Obesity and Lifestyle Study with 4,841 participants and collected in 1999-2000 and 2004-2005. The results showed participants with a baseline of abdominal obesity had a reduction in physical activity within the five years before the final survey. Women showed a reduction in physical activity if they watched more than 4 hours of TV per day. People who have abdominal obesity are less likely to be active, which would indicate that individuals who are already overweight are less likely to workout or be active. This increases the likelihood of these people to remain obese (Lakerveld et al, 2011). Women who are overweight and watch more than 4 hours of TV tend to have decreased time of physical activity compared to women who are normal weight and watch less than 4 hours of TV.

Recent research has focused on increasing physical activity and decreasing sedentary behavior in adolescents (Denton et al, 2013; Carson et al, 2013). Basterfield and colleagues (2011), however, believe the main focus should be on when children start to decrease their physical activity time. Basterfield and colleagues (2011) examined 405 seven year olds in a longitudinal study over 24 months where the children wore an accelerometer during waking hours to track their movement for 7 days (accelerometer was removed before bed or when going into water). Overall, the moderate-to-vigorous physical activity (MVPA) levels were low with seven year olds getting 26 minutes per day, and nine year olds getting 24 minutes per day. At both time points, only 9 out of 405 children reached 60 minutes of MVPA. Girls had significantly greater decreases in physical activity over the two years than boys. Children at the age of seven spent 78.0% of their time being sedentary, and significantly increased to 81.1% when they were nine. These data suggest that society should start to monitor children's activity at younger ages, since seven and nine year olds are spending the majority of their time being sedentary (Basterfield et al, 2011).

A recent study examined the effects of different intensity exercises on cardiorespiratory fitness in children (81 girls, 54 boys) ages 10-14. The children wore a triaxial accelerometer all day for seven days tracking their activity level and at the end of the seven days did a maximal cardiorespiratory fitness test on a cycle ergometer. Results showed a gender differentiation for varying intensities beneficial for cardiorespiratory health. Vigorous and hard physical activities were beneficial for cardiorespiratory fitness in boys, whereas, moderate, vigorous, and hard were beneficial for girls (Denton et al, 2013). In the article, the researchers explained this difference

because girls tend to spend most of their time in light physical activity, which does not improve cardiovascular health or burn a lot of calories. The more time children can spend in moderate levels of activity or higher will improve their cardiorespiratory fitness. This study highlights the benefits for children having higher intensities for exercise. Children need to exercise at higher intensities for them to receive the health benefits.

Overweight individuals engage in greater sedentary behavior and less physical activity compared to normal weight individuals (Lakerveld et al, 2011). Sedentary behavior needs to be monitored starting at earlier ages when children begin to spend more time being sedentary compared to being active (Basterfeld et al, 2011). The increased sedentary behavior and reduced physical activity can be harmful to the body, which can cause a decrease in cardiorespiratory fitness (Denton et al, 2013). Adolescents who spend more than the recommended two hours per day being sedentary also have an increased risk for metabolic syndrome (Johnson et al, 2009). Metabolic syndrome is a cluster of issues that include: increased blood pressure, low high-density lipoprotein cholesterol concentrations, elevated triglycerides, and elevated fasting glucose concentrations. These five factors are also closely linked to type 2 diabetes mellitus and cardiovascular diseases. The accumulating sedentary time in children and adults is decreasing physical activity, which is leading to the obesity epidemic.

Mindful vs Mindless Eating

One of the major variables of obesity is the increased food consumption in the US. Increased consumption of food is thought to be from mindless eating (Hendrickson & Rasmussen, 2013). This is when eating becomes an unconscious act to do external

variables such as eating until all the food is gone or the end of a television program. There are other factors such as larger dinner parties, larger place settings and dimmed lights (Hendrickson & Rasmussen, 2013). Researchers attribute these factors to gaining weight across time. Researchers are now looking into a way to decrease these effects on food consumption by looking into mindfulness eating. Mindfulness is a term defined as "paying attention in a particular way: on purpose, in the present moment, and non-judgmentally" (Kabat-Zinn, 1994). Mindfulness eating has been shown to have a positive effect on obesity by decreasing food consumption.

Ogden and colleagues (2013) examined how distractions affected mindless eating. Eighty-one female participants, 18-40 years old, were placed into one of four different conditions for the experiment: driving simulator, a model car that simulates actual driving; social environment where the participants would talk to a research assistant; watching an episode of friends; and sitting by themselves. Each condition lasted for seven minutes where they were given 'hula hoops', a potato chip with a hole in the middle, in a medium sized bowl with a weight of 100g. After each condition, the bowl was reweighed to see how much was consumed. Results showed that participants in the television conditions consumed a significant amount more than the driving and social conditions. When individuals eat alone, they participate in mindful eating because they are able to focus more on the food that is in front of them without getting distracted. While watching TV, individuals are distracted and consume more food subconsciously. When your mind is completely distracted, it is easier to engage in mindless eating (Odgen et al, 2013).

Hendrickson and Rasmussen (2013) conducted a study with 102 participants (73 females, 27 males, mean age 25.46 years old) randomized to an experimental group that involved informational sessions on mindfulness eating and the control group, watching "Learn Nutrition" on DVD. The informational sessions consisted of 50 minute lessons where information on how to think about food when eating and breaking it down into different areas such as taste, texture, and smell. The participants were encouraged to write down every reaction they felt while eating. There were four different types of food they were asked to do this for, which took 10 minutes a piece. The control group did not have an instructor in the room with them while they were watching the DVD, and were simply instructed to follow the DVD. The experimental group results showed a more self-controlled pattern and less impulse when responding to food after their training. The control group did not exhibit any changes. The experimental group showed beneficial ways for people to control impulsive eating. When people concentrate on what they are eating they are more in control of their eating habits, which could be beneficial for combating obesity in people who do not have control of their eating habits (Hendrickson & Rasmussen, 2013).

Tapper and colleagues (2009) examined how mindfulness eating can have an effect on weight loss. The participants (19-65 years old) were recruited if they were already in the process of trying to lose weight, so they would be able to continue their plan, as well as, adding in the mindfulness eating criteria. The mindfulness eating intervention consisted of four workshops lasting two hours a piece for the experimental group and nothing for the control group. Six months after the study, the results showed that people in the experimental group who followed the workshops post intervention

lost 2.32 kg and increased their activity sessions to 3.11 sessions per week, compared to a control condition lost 1.35 kg and increased activity sessions to 2.81 sessions per week. Mindful eating is important when people are trying to lose weight; since they are making more controlled decisions on food they are able to lose weight. This is especially beneficial for people who increase the sessions they work out per week (Tapper et al, 2013).

There are a lot of different areas that can contribute to mindless eating. Distractions are a key contributor. As soon as people get distracted from internal cues of hunger and satiety by external factors, this increases the chances of someone eating mindlessly because food intake will not have an effect on their desire to eat (Odgen et al, 2013). There are ways to increase mindful eating such as eating by yourself (Odgen et al, 2013) and taking the proper amount of time to assess food while eating (Hendrickson & Rasmussen, 2013; Tapper et al, 2013). Mindful eating can help in weight loss by being conscious of food choices (Tapper et al, 2013).

Sedentary Effects on Children's Food Choice

Children are easily influenced when choosing what types of food they should consume. When children are just starting to eat solid foods, it is good to have their parents and other people around them eat healthier fruits and vegetables, because children are more likely to mimic their food consumption with those around them. The more food choices children are exposed to when they are younger the more willing they will be to try different foods as they get older (Harris, 2008). Table 1 illustrates the sedentary effects on children's food choice.

Table 1

Sedentary Effects on Children's Food Choice

Study	Study Purpose	Design and Procedures	Number of Participants	Study Results
Coon et al (2001)	To examine the relationship between children's food consumption in front of the TV.	3 nonconsecutive 24-hour dietary recalls were conducted with each child	91 parent-child Dyads Mean age of the children 10 years	Children from families with high TV use: on average 6% more of their total daily intake from meats; 5% more from pizza, salty snacks, and soda; and nearly 5% less of their energy intake from fruits, vegetables, and juices than children from families with low TV use
Epstein et al (2008)	To examine the effects of reduced TV and computer usage on young children's BMI.	Randomized controlled clinical trial. Intervention group had a device hooked up to the TVs and computers in the house to monitor the usage with a goal of 50% reduction from baseline	70 children 4-7 with BMI at or above 75th percentile for age and sex	Intervention group reduction in sedentary behaviors (P<.05), zBMI (P<.05), and energy intake (P<.05) versus control group. Change in TV viewing was related to change in energy intake (P<.001) and not to change in PA. Prevalence of obesity among girls in intervention group was reduced (P=.03)
Gortmaker et al (1999)	To evaluate the impact of a school-based health Behavior intervention	Randomized field trial with 5 control and 5 intervention schools with pre and post measures of obesity. Intervention group participated in Planet Health sessions	1295 6th and 7th graders Mean age 11.7 years	Intervention group for boys and girls reduced TV hours, increased fruit and vegetable intake. Reducted TV hours for girls predicted reduced obesity prevalence *(P=.02)*

Epstein and colleagues (2008) examined the effects of reduced TV and computer usage in young children. Seventy children ages 4-7 years old with a BMI that was at or above the 75th percentile for age and sex were divided into a control and intervention group. The intervention group had a TV allowance device put on each of the TV and computers in the house to monitor the usage. The amount of time allotted for TV watching was based off of baseline values, which was reduced by 10% initially until the intervention group reached a 50% reduction in time. This study was self-reported and did not take place in a lab or clinical setting. There was a reduction in energy intake for children in the intervention group, especially for the ones who ate

regularly while watching television. The results of this study could have a huge effect on reducing childhood obesity. Children who reduce the amount of time they are eating in front of the TV tend to reduce their energy intake, which means even if children are not increasing their physical activity at least they are decreasing their energy consumption. This will help children get closer to neutral energy balance (weight maintenance) and negative energy balance (weight loss) (Epstein et al, 2008). Other researchers in the field have praised this research for leading the way to decrease sedentary behavior by reducing TV time (Maddison et al, 2011).

Maddison and colleagues (2011) are in the process of replicating the previous study by Epstein and colleagues (2008). The researchers are modifying the study so it is more applicable to people who are in New Zealand. The new study will have more clearly defined roles for the primary caregiver, such as encouraging their children to do different activities than watching TV; promoting more family activity times that do not revolve around the TV; and each family will be provided with equipment that will promote none sedentary behaviors. The results of this study will be beneficial when it comes to weight loss for New Zealand's children. Researchers are hoping this study will help promote healthier activities of daily living by increasing PA, decreasing sedentary behavior, and increasing healthier food consumption in children. The results of this research will not be published until end of 2013 (Maddison et al, 2011).

Coon and colleagues (2001) conducted a study on children's food consumption during meal times with and without a TV on. The participants were parents and their fourth to sixth grade child. Fifteen food groups were assessed, including fats, vegetables, fruit, red meats and sodas, to name a few. Results showed that children who

watched television during 2 or more meals per day increased their meat consumption by 6%; increased their salty and snack foods by 5%; and decreased their fruit, vegetable, and juice consumption by 5% for their overall energy intake compared to children who did not watch TV during meals or only watched TV during one meal (Coon et al, 2001). These results indicate that children who consume more than 2 meals per day in front of the TV tend to increase unhealthy food choices and overall energy intake.

Gortmarker and colleagues (1999) conducted a school-based intervention to reduce pediatric obesity within the Boston, Massachusetts' area. The teachers in the intervention schools were shown how to increase positive behaviors for the children by having them decrease TV time to less than two hours per day; increase fruit and vegetable consumption; decreased high fat food intake; and increased MVPA. The results showed there was a decrease in baseline obesity levels in females in the intervention group from 23.6 to 20.3%, whereas, the control group increased from 21.5 to 23.7%. Obesity levels decline in both conditions for males. There was a statistically significant decrease in boys and girls TV watching in the intervention group compared to the control group. The girls also had a statistical significance in decreased energy intake and increased food consumption from the intervention to the control group (Gortmaker et al, 1999). This article is beneficial because it shows with increased sedentary time there is an increase in obesity. It also shows how consuming different foods can make a difference on children's weight status.

Sedentary behaviors have been shown to increase high-energy low nutrient-dense foods, which can be associated with an increase in childhood obesity. There needs to be a focus on getting children away from TV to find alternate activities for

them to become more physically active. As children divert their time away from the TV, they can potentially decrease energy intake and expend more energy.

Physical Activity Effects on Food Choice

Physical activity is associated with the type of food people consume. Table 2 illustrates acute bouts of exercise, body composition, and gender can have an affect on food choices made by children post exercise (Thivel et al, 2001; Bozinoviski et al, 2009; Saunders et al, 2014).

Women have been shown to compensate for exercise-induced energy expenditure after a bout of high intensity exercise. Pomerleau and colleagues (2013) examined the effects of exercise intensity on food intake and appetite. Thirteen moderately active, normal weight, women ages 18-30 participated in three sessions: seated for 1 hour and 15 minutes reading or writing (control); low-intensity exercise walking on the treadmill at 40% of VO2 peak; and high intensity exercise walking on the treadmill at 70% VO2 peak both exercise sessions went until energy expenditure of about 350 kcal. The participants were given three meals and snacks the days they were present for the experiment, and were also asked to keep a food log of what they consumed on the off days. After the high intensity exercise session, the participants significantly increased energy intake from the control by 127 kcal at lunch one hour after exercise and there was not a significant difference between light intensity exercise energy intake and the control group. There was no difference at dinner later in the day for both exercise groups. There were increases in macronutrients (fat, protein, carbohydrates) during the interventions. At lunch, there were significantly higher fat

and protein intakes for both high and light intensity exercise than the control condition (Pomerleau et al, 2013).

The results of this study suggest that normal-weight women compensate the energy they have expended during high intensity exercise by increasing their energy intake during the next meal. Different intensities influence what macronutrients will be increased when compensating for the energy expended during high intensity exercises. It is unknown whether overweight women also compensate their food intake after exercise, or if the opposite is true.

King and colleagues (1997) examined how HIE effects hunger and energy intake in males. Eight males, mean age 26 years old, who were normal weight and regularly exercised participated in the study. They were asked to do two bouts of running on a treadmill for 50 min at 70% of their heart rate max one bout was in the morning and the other in the afternoon. There were two days of rest, which were held as the control group. On day one, the participants would do a bout of exercise in the morning and afternoon then follow it up with a rest day, and then wait a week before they repeated it. Participants were asked to keep a food log of what they consumed on each of the days. Results showed there was no increase in hunger from the exercise day to the control day. The exercise days expended about 1200 kcals, but were not compensated by an increase in energy intake. There was no significant difference in macronutrients between the experimental and control group (King et al, 1997). This study suggests that men do not compensate for energy expended during exercise, which could lead to gender differences in energy compensation after exercise. However,

similar to the previous study with women, it is unknown whether overweight men also do not compensate their food intake after exercise.

In a recent study, Saunders and colleagues (2014), examined whether children would compensate energy intake for increased bouts of sedentary or physical activity. Boys and girls ages 10-14 participated in the randomized cross-over study design. There were three different conditions that the children participated in: 1) eight hours of being completely sedentary with four hours of watching movies, two hours solving puzzles and other forms of mental work, and two hours of video games; 2) sedentary with breaks where the children walked on a treadmill for two minutes at 30% of their VO2 peak every 20 minutes then continued their sedentary activity; and 3) sedentary with breaks and physical activity which was the same as the sedentary and breaks with two bouts of walking at a light intensity for 20 minutes. Immediately after each condition, the children were provided with a buffet meal where they would measure the weight of the food before and after the child was done eating. Results showed no compensation for children decreasing energy intake during sedentary bouts or increasing energy intake during bouts of physical activity (Saunders et al, 2014). The results of this study are intriguing because they did not find children compensating energy intake for sedentary or physical activities where other studies have found compensation (Thivel et al, 2011; Bozinoviski et al, 2009).

A study by Thivel and colleagues (2011) assessed the effect of an acute bout of exercise on obese adolescent food consumption. The 14 obese adolescents (7 male, 7 female), 13-15 years old, each participated in two different sessions: an exercise session and a sedentary session (45 min). The experimental sessions lasted for one day 0730 am

to 0930 pm where the participants would partake in the two different sessions (sedentary and physical activities) and have three meals served to them. The children were asked to eat until they were full. Results showed a significant reduction in total energy intake for the whole day during the exercise session. Boys and girls did not differ in energy intake between the two experimental sessions (Thivel et al, 2011). Exercise was shown to be a good way to reduce total energy intake for the whole day in obese adolescents, however, this study also showed there was no gender difference on energy intake compensation after exercise.

Bozinoviski and colleagues (2009) assessed ventilatory threshold, shown during a graded submaximal fitness test where ventilation increases disproportionally to oxygen consumption, effect on short-term food intake in normal weight 9 to 14 year olds (14 boys, 15 girls). Children participated at random in four different sessions, two at rest and two exercise sessions for 15 minutes (short duration) and for 45 minutes (long duration) walking on a treadmill. After each session, the children had to wait 30 minutes before they were provided pizza for lunch. Results showed an increase in appetite, desire to eat, and hunger to be diminished in short duration and further reduced in long duration. Food intake in short duration and long duration was similar at rest in both boys and girls. There was a trend, however, for girls to increase food intake after long duration, but the researchers could not be confident on this since the study was underpowered. Girls compensated 42% of their energy expended during the long duration, whereas, boys only compensated -13% (Bozinoviski et al, 2009). The results of this study show there might be a gender influence on food consumption post exercise during long duration exercises.

Sedentary and physical activities have been shown to have different influences on food consumption in children (Saunders et al, 2014; Thivel et al, 2001; Bozinoviski et al, 2009). After normal weight females have completed a bout of HIE, they increase their food consumption to compensate for the energy they have expended (Pomerleau et al, 2013). Normal weight men, however, do not compensate by increasing food for the amount of energy expended after exercise (King et al, 1997). Studies for normal weight adolescence have shown different results when it comes to energy consumption after exercise or sedentary activities. One showed there was no difference in energy consumption for boys and girls when compensating for energy expenditure in sedentary or physical activity conditions (Saunders et al, 2014). Girls in another study, however, had a trend for increasing food consumption compensating for energy expenditure (Bozinoviski et al, 2009). In obese adolescents, there was a decrease in energy consumption for boys and girls after energy expenditure (Thivel et al, 2011).

These studies are beneficial for the proposed study. The proposed study is different from the previous research, as it will examine snack choice rather than full meals and physical activity/sedentary behavior. The proposed study utilized similar conditions to compare food choice as Saunders and colleagues (2014). Additionally, it is unknown whether gender influences energy consumption after physical and sedentary activities, which this study also examined.

Table 2

Physical Activity Effects on Food Choice

Study	Study Purpose	Design and Procedures	Number of Participants	Study Results
Pomerleau et al 2013	To examine the effects of exercise intensity on energy intake in women.	Cross-over design, 3 conditions: no exercise, low intensity exercise (LIE), and high intensity exercise (HIE). After each condition, a buffet style lunch and dinner was provided with snacks in the afternoon and evening.	13 moderately active females mean age 22.2 mean BMI 22.2	Increase energy intake (EI) at lunch after HIE compared to control (P=.02), decreased EI for LIE at lunch compared to control (P<.001)
King et al (1997)	To examine the effects of high dose (two-HIE sessions) of exercise on EI and subjective moods (hunger and mood).	Cross-over design, exercise session: 2 consecutive days with first day (Ex 1) having 2 bouts of exercise and the second day (Ex 2) is sedentary, control session: two consecutive days of sedentary activity.	8 males mean age: 26 mean BMI: 22.4	Participants had a lower average feeling of hunger all day after Ex1 compared to Ex2 (P<.05). There was no incrase in EI on Ex1 or EX2 to account for the energy expended.
Saunders et al (2014)	To determine the acute effect of prolonged sitting on ad libitum food intake and spontaneous physical activity (PA).	Randomized cross-over design, 3 conditions: 1) sedentary; 2) sedentary with 2 minute breaks; 3) sedentary with 2 20 minute breaks with a buffet meal immediately following each condition.	12 boys Mean age: 12.8 Mean BMI (kg/.m2): 19.4 8 girls Mean age: 11.3 Mean BMI (kg/m2): 17.4	There was a significant difference in dedentary behavior and PA (P<.01), but there was no significance in ad libitum eating immediately after any condition.
Thivel et al (2011)	To examine gender differences in terms of EI and appetite feelings after an acute bout of physical exercise among obese adolescents.	Randomized cross-over design, 2 conditions; sedentary and PA for 45 minutes, each day a standard breakfast was had with an ad libitum lunch and dinner. Lunch was held after each condition.	7 boys Mean age: 13.4 Mean BMI (kg/m2): 31.9 7 girls Mean age: 14.8 Mean BMI (kg/m2): 35.98	The PA condition showed a total reduction in EI for the whole day compared to the sedentary condition (P<.001). There was no significant difference in gender when comparing EI after each condition.
Bozinoviski et al (2009)	To determine the effect of duration of exercise at ventilation threshold (Vet) on subjective appetite and short-term food intake in normal weight boys and girls.	Within subject repeated measures design, 4 conditions: 1) Sedentary short duration (SD) 15 minutes; 2) Sedentary long duration (LD) 45 minutes; 3) 15 minutes of SD exercise 4) 45 minute LD exercise, exercise conditions were done at VeT, pizza meal provided 30 minutes following condition.	14 boys Mean age: 12.6 Mean BMI (percentile): 55.9 15 girls Mean age: 11.7 Mean BMI (percentile): 52.8	Average appetite, desire to eat and hunger (p<.05) was reduced by SD exercise. In contrast, LD increased average appetite, desire to eat, and hunger (p<.05). There was no significant difference in gender when comparing EI after SD and LD exercise.

Summary

This literature review provides evidence that when children are eating during sedentary activities, they are more likely to choose higher calorie, less nutrient-dense food, even though there is a decrease in energy expenditure (Coon & Tucker, 2002). When children are working out at HIE, they tend to be in a negative net energy balance because there is a decreased desire to eat. It is unknown whether gender makes a difference in food intake following sedentary or physical activity (Bozinoviski et al, 2009; Saunders et al, 2014; Thivel et al, 2011). There is a gap in the literature on snacks (healthy vs unhealthy) immediately after exercise and exercise breaks within sedentary behaviors in children (9-13). This study is necessary to understand children's chosen snack foods following physical and sedentary activities. When children are sedentary they might increase their energy intake, which could lead to a positive energy balance. Increasing physical activity in children could lead to decreased food consumption in snacks leading them to a healthier food option. The present study focused on three different conditions (one hour active, one hour sedentary, and one hour divided with bouts of 15 minutes sedentary and five minutes active). Immediately at the end of each condition, participants chose one snack. This study may inform parents and the literature on the association between various child activities (sedentary or physical activities) and child snack food preferences. Results from this study may be used to understand the relationship between energy expenditure and food choice (energy intake), to help combat the childhood obesity epidemic.

CHAPTER III

METHOD

Participants and Design

A volunteer sample of children (n=24) ranging from 9-13 years of age were recruited. Participants were recruited from fliers posted throughout the community (e.g., YMCA, restaurants, grocery stores, etc.), school newsletters and electronically via community list servers. When parents called in to ask about information to sign up for the study, they were asked if their child has any food allergies or intolerances. The children received $30 and parents received $20 for participating in surveys and bringing their children to the research facility. The Institutional Review Board at the University of North Dakota approved this study.

The children participated in a true experimental design where all of the children were exposed to all three conditions. Condition 1: children were sedentary for 60 minutes. Condition 2: children were physically active for 60 minutes at a moderate to vigorous intensity. Condition 3: children alternated between 15-minutes of sedentary behavior and a 5-minute moderate intensity physical activity for a total of 60 minutes. Immediately following each condition, the children chose between two unhealthy and healthy food options. The children were randomized into order of receiving conditions based on when they enrolled in the study. Specifically, a total of 24 participants were

recruited to ensure that four children were randomly placed in one of the six possible condition sequences (see figure 1).

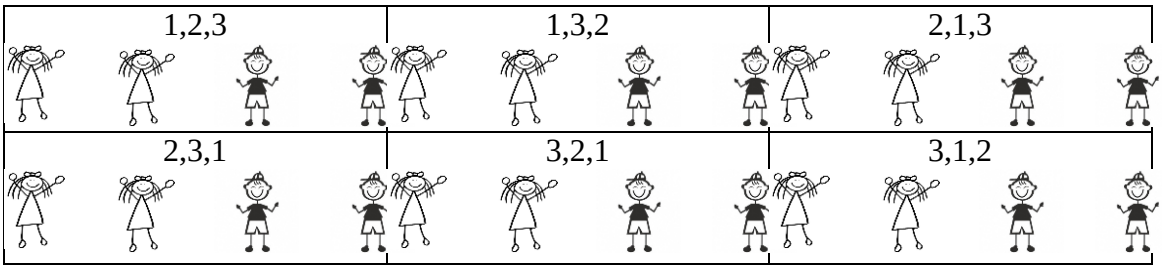

Figure 1. Participant Randomization (1=Sedentary, 2=Physical Activity, 3= Sed & PA)

Procedures

This study was conducted over three days/sessions in a three-week period. At the first session and upon the arrival of the participants at the Hyslop building, a trained research assistant greeted the parent and child, and took them to a private, quiet office. They were given information about the study and asked to sign the informed consent. The child had their height in centimeters and weight in kilograms measured by a trained research assistant. While the child was getting their height and weight measured, the parent completed a survey. The survey assessed what types of food are available in the house, sedentary and physically active behaviors of the child, and demographic information. Immediately following the measurements and survey completion, participants were taken to the laboratory where the research was conducted. For sessions two and three the participants met at the laboratory where the previous research sessions were held.

In the laboratory during the three sessions, the child was asked to wear an accelerometer armband on their right arm that assessed caloric expenditure and activity

level. The child was brought to a gym area where he/she completed one of the three conditions. The gym was set up accordingly for the conditions the child was randomly assigned. Condition 1 was the sedentary behavior and had a TV, DVD player, and movies for the children to watch. Condition 2 was the physical activity and had different games and circuits set up. The games were 2-on-2 soccer and kickball in a racquetball court. The circuits consisted of activities such as: sprints, wheel barrel races, crab walks, grape vine, bear crawl, jump rope, hula hoop, jumping jacks, and scooter races. Condition 3 was a mix of sedentary and physical activities. The set-up for condition 3 had the TV and DVD player, along with different types of circuit activities to do. Then at the end of each condition the children were presented with food choices, two healthy (fruit and vegetable) and two unhealthy (chocolate candy bar: Hershey's, and potato chips: Lays, snack size bag). At the end of each session, the children went to a separate room where they chose what snack they wanted. Only one child was able to choose a snack at a time. The research assistant left the room so not to influence the child's choice. The children came out of the room when they have chosen their snack, so the research assistant was able to record which snack they chose for each condition. At the end of each session, the child and parent were thanked for their participation. After session 3, the child and parent were given their money for participating in the study. The IRB at the University of North Dakota approved all procedures.

Measures

Demographics- Demographic information was reported by a self-report parent survey. Socioeconomic status was measured by one item assessing whether their child qualified for free or reduced lunch. Responses were used to determine the

socioeconomic status of the family (low or high). Education level was assessed by report of highest level completed, ranging from some high school to post graduate school. Ethnicity for parent and child was reported separately (CDC). Parent and child gender was assessed. Lastly, parent and child age was reported by date of birth.

Body Mass Index- Height was measured in centimeters using a portable stadiometer (Seco Corp, Model 213, Hamburg, Germany). Weight was measured in kilograms using a digital scale (Seca Corp, Model 876, Hamburg, Germany). To ensure reliability, height and weight was measured twice, and if the first two measurements differed by more than 0.5cm or 0.1kg, respectively, a third measure was taken. The two closest measures were averaged and used to calculate BMI. Raw BMI scores was converted to percentiles using the Centers for Disease Control and Prevention (CDC) norm reference standards (Kuczmarski et al., 2000). Child weight status is based on their height, weight, age and sex. Overweight is defined as ≥ 85th to <95th, and obese is ≥95th percentile (Kuczmarski et al., 2000).

Availability: The parent survey had categories for food, physical activity equipment, and sedentary activities available in their homes.

Food: Twenty-eight fruits and 18 vegetables were listed and parents selected "yes" or "no" as to whether or not these items are available in the house (Baranowski et al., 2008; Baranowski, 2003).

Physical activity: There were 20 different physical activity items listed as being available (yes) or not being available (no) for the parent to choose from (Gattshall et al, 2008). A few examples of the physical activity items are: basketball and hockey equipment, bicycle, and inside playroom.

Sedentary Activity: There were seven different technologies that promote sedentary behavior. The parent was asked if the technologies are available in the home and/or in the child's room (Bryant et al, 2008). Sedentary activity technologies included: video game system, TV, computer, and DVD player.

Child Behavior: On the parent survey, questions assessed children's food intake and the amount of time children spend being physically active or sedentary.

Food intake: Parents had two questions on fruit and vegetable servings per day for their child. The amount of servings was 0-4 or more per day (Patrick et al, 2001). There was also a question on how many times their child consumed fast food on a scale from 0-2 or more times per day.

Physical activity: There were two questions pertaining to how many days per week their child accumulates 60 minutes or more of physical activity. The questions on how many days that week and on a typical week the child gets 60 minutes or more of physical activity (Prochaska et al, 2009).

Sedentary activity: There were four questions looking at how much time their child spends in front of a screen to increase their time being sedentary (Robinson et al, 2003).

Energy Expenditure- Children were wearing an armband accelerometer (Body Media) on their right arm. Each child wore the armband for an hour during each condition. The armbands were put on at the beginning of each condition. The accelerometer tracked the amount of calories expended during each condition. METs were also recorded to show if the child was in low, moderate, or vigorous intensity.

Food Choice- Children were asked to choose one of four different snacks when they are done with each condition. The snack options included chips, chocolate candy bar, apple slices and carrots. I chose chips and chocolate because they are salty and sweet foods. The apples and carrots are some of the sweetest fruits and vegetables.

Data Analysis

Hypothesis One

Due to a categorical dependent variable (snack choice), non-parametric statistics were necessary. The Friedman Test is the non-parametric alternative to the repeated measures Analysis of Variance (ANOVA). The Friedman Test examined the effect of condition (SB, Active, SB-A) on food choices. It was not necessary to control for order of receiving the condition, since all participants were randomized to receive one of the six possible orders. Post-hoc analysis included the Wilcoxon Signed Rank tests for each individual pairing (SB to Active; SB to SB-A; Active to SB-A).

Hypothesis Two

Similar to the first hypothesis, due to the categorical nature of the dependent variable (snack choice), the non-parametric alternative of an Independent T-test examined the difference in food choice between boys and girls. Thus, the Kruskal-Wallis test compared snack choice between boys and girls for all three conditions, separately.

Additionally, the Kruskal-Wallis test examined the difference in food choice between overweight and normal weight children.

Lastly, to predict snack choice from the parent survey variables, a logistic regression analysis was conducted. A logistic regression was used due to the categorical

nature of the dependent variable (snack choice). Healthy snacks were set as the reference group (=1) compared to unhealthy snacks. For all analyses, p-value was set at 0.05.

CHAPTER IV

RESULTS

Participant Characteristics

A total of 24 children participated in the study. Briefly, participants had a mean age of 10.6 years, 13 were male (54.2%), 22 were white (91.7%), 4 were eligible for free or reduced lunch (16.7%), and 19 were normal weight (79.2%).

The participant characteristics can be found in Table 3.

Table 3

Participant Characteristics

	Participant (n=24)
Sex: male	13 (54.2%)
female	11 (45.8%)
Mean Age, SD	10.6 (1.6)
Ethnicity: white	22 (91.7%)
no answer	2 (8.3%)
BMI: normal weight (<85th percentile)	19 (79.2%)
overweight/obese (>85th percentile)	5 (20.8%)
Free or Reduced Lunch: qualified	4 (16.7%)
did not qualify	20 (83.3%)
Physical Activity Guidelines: met	11 (45.8%)
did not meet	13 (54.2%)
Fruits and Vegetable Guidelines: met	5 (20.8%)
did not meet	19 (79.2%)
Screen Time Guidelines: met	10 (41.7%)
did not meet	14 (58.3%)

When comparing overall snack choice of all three conditions, the non-parametric alternative to the repeated measures analysis was used (Friedman Test) to analyze the data. Overall, there was not a statistically significant difference in the overall model comparing the three conditions on snack choice (p=0.15; Chi Square=3.8). Table 4 illustrates the results of the Friedman test, and includes mean steps and Kcalories expended during each of the three conditions. The Wilcoxon Signed Rank Post-Hoc test was used to compare the three conditions to each other (a total of three comparisons). The Wilcoxon Test showed no statistical significance (p>0.05): Sed to PA (p=0.06); PA to Mixed (p=0.41); Sed to Mixed (p=.26).

Table 4

Comparison of Three Conditions on Snack Choice

Condition	Mean (SD)	Average Steps	Average Calories
Sed	0.33 (0.5)	30	53.3
PA	0.54 (0.5)	4,842	258.6
Mixed	0.46 (0.5)	1,243	97.7

**no statistical difference from the Friedman Test Repeated Measures*

To evaluate our secondary aim, we examined gender differences for snack choice following all three conditions. There was not a significant difference between boys and girls for snack choice after any of the PA (Chi-Square=0.001; p>0.05), SED (Chi-Square=0.322; p>0.05), and mixed conditions (Chi-Square=0.595; p>0.05). Thus, there was no difference between girls and boys on choosing a healthy or unhealthy snack option after a given condition.

Overweight/obese children compared to normal weight children were more likely to choose a healthier snack option after the PA condition (Chi-Square=1.63;

p=0.02). In the SED (Chi-Square=0.12; p>0.05) and mixed (Chi-Square=0.49; p>0.05) conditions, however, there was no significance between snack choices the overweight/obese children chose compared to the normal weight children.

Table 5 illustrates the results of the logistic regression analysis for all three conditions, independently. The logistic regression analysis of the parent survey to predict snack choice in children was not statistically significant (p>0.05).

Table 5

Results of the Logistic Regression Analysis to Predict Child Snack Choice from Parent Survey Items

	Healthy	Sedentary Unhealthy	PA Unhealthy	Mixed Unhealthy
Fruit Available	1	1.15	1.41	1.85
Vegetables Available	1	1.09	1.72	2.86
Snack Available	1	1.06	0.56	0.00
PA Equipment Available	1	1.05	1.05	3.31
TVs in home Child Min	1	0.49	1.20	0.10
Screen Time	1	1.00	0.98	1.04
Fruit and Vegetable intake	1	1.77	0.57	2.27

CHAPTER V

DISCUSSION

Approximately 17% of children in the US are obese, causing an overwhelming concern in society (CDC). Children who are overweight or obese are more likely to become overweight or obese adults with an alarming number of negative health consequences (Byers et al, 1993; Dietz et al 1997; Ogden et al, 2007). This study specifically investigates how modifiable lifestyle behaviors such as screen time (ST), PA, and sedentary behavior may effect diet. Han and colleagues (2010) suggest studies investigating modifiable lifestyle behaviors can be effective for combating the obesity epidemic. The primary objective of the present study was to investigate whether children chose healthier snack options after a 60 minute bout of PA, 60 minute bout of SED activity, or 60 minute bout of mixed PA and SED activity. The purpose of this study was to examine child behaviors (active versus sedentary), and the effect on food choice. More broadly, it is important to understand whether PA has a positive impact on children choosing healthier food options, when available. The results of this study may increase our understanding of children's behaviors (ST, PA, SB) and energy expenditure effect on food choice when combating childhood obesity.

To our knowledge, this is the first study investigating how sedentary and physical activity has an effect on children's snack choice. Contrary to our first hypothesis, there was no statistical significance between the three conditions for snack

choice. Similarly, when examining our secondary aim, gender was not significant in comparing snack choice (healthy or unhealthy) between males and females after any of the three conditions. Weight status of the children was significant when choosing a snack option after the PA condition, meaning overweight/obese children were more likely to choose a healthier snack option than the normal weight children. However, there was no difference in snack choice following the other two conditions (Sed and Mixed) between normal and overweight children.

An important aspect of this study was to examine if children chose a healthier food option following the PA condition compared to the SED condition. When comparing snack choice to all three conditions, there was a non-significant effect. Although the post-hoc analysis illustrated a trend for significance following the SED condition, where children were more likely to choose an unhealthy snack after the SED compared to after the PA condition. The present study's results are consistent with other studies that have examined the relationship between sedentary behaviors and food consumption. There have been multiple studies conducted on the effects of food consumption while watching TV (Coon & Tucker, 2002; Maddison et al, 2011; Epstein et al, 2008). Children are more likely to consume higher calorie, less nutrient-dense food, when participating in sedentary activities with decreased energy expenditure (Coon & Tucker, 2002). For every additional hour that children increase their television viewing, they are more likely to consume an additional 167 kcals. The additional kcals are more likely to come from the food advertised on the TV, which are high-calorie, less nutrient-dense foods (Wiecha et al, 2006). Children who reduce the amount of time they eat in front of the TV will reduce their energy intake (Epstein et al, 2008). Children

who are sedentary are less likely to consume fruits, vegetables, whole-grain products and eat breakfast compared to children who engage in more than 60 minutes of PA daily (Morin, Turcotte, & Perreault, 2013). Thus, if children reduced the amount of time they are in front of the TV not only will they potentially reduce their energy intake, but they may also be more physically active which would increase their energy expenditure.

The secondary aim of the study was to examine whether boys chose less calorie-dense snacks than girls after all three conditions. In the present study, there was no significant gender effect on food choice. This study had the same results as other studies, however, these studies examined differences in food consumption after a meal (Thivel et al. 2001; Saunders et al, 2014). Different studies have shown varied results for gender effect on food choice in children. One study showed girls compensated for 42% of their energy expended during a 45 min exercise session, however, this was only a trend due to the study being underpowered. The boys in the same study showed a negative (-)13% compensation for food after the same session (Bozinoviski et al, 2009). Similarly, an intervention study done to help promote a decrease in TV; increased fruit and vegetable consumption; decreased high fat food intake; and increased MVPA in children, showed there was a difference between boys and girls. Both boys and girls decreased in TV time, but only girls had a statistical significance in decreased energy intake and increased food consumption from the intervention to the control group (Gortmarker et al, 1999).

The present study, however, looked at a smaller portion of food, snack choice, instead of a full meal option. Three snacks make up 27% of the average child's total EI, where the rest of the EI is coming from meal consumption (Piernas & Popkin, 2010).

One snack may only be roughly 9% of the total EI intake for the day for a child. The studies that found a difference in food consumption in gender after exercise could due to the greater number of potential calories being consumed (Gortmarker et al, 1999; Bozinoviski et al, 2009). The lower number of calories in this study could potentially be the reason why there was no significance in food consumption between genders.

The results from the present study shows overweight/obese children were more likely to choose a healthy snack option after PA condition compared to the normal weight children ($p<.01$). Other studies have shown comparable results (Thivel et al, 2011; Saunders et al, 2014). Thivel and collegues (2011) did a study with obese adolescents showing after an exercise session there was a total reduction in energy intake for the meals for the whole day compared to the sedentary session. Saunders and colleagues (2014) examined whether normal weight children would compensate for energy intake with increased bouts of sedentary or physical activity. The results showed there was no compensation for food during either condition (Saunders et al, 2014). Our findings suggest that increasing the amount of PA overweight/obese children get on a daily basis could reduce their total EI by choosing less-calorie, nutrient-rich foods. It has been suggested that children ages 5-17 are conscientious of how much they weigh (Morin et al, 2013). The overweight children in this study could be partaking in weight loss strategies by choosing healthy instead of unhealthy food choices, following the PA condition.

Research has shown the home environment has a large influence on children's food choices, however, the current study did not show a difference in home availability and child behaviors on child snack choice. For example, Baranowski and colleagues'

(2007) results showed when homes have more fruits and vegetables available children are more likely to have greater fruit and vegetable consumption. This novel study, however, was not in the home environment, so understanding what influences children's snack choices outside of the home is important.

Strengths and Weakness of the Study

This is a small, pilot study with several strengths and limitations. Strengths included that participants were randomized in order of receiving conditions by when they signed up to participate in the study. Second, there was almost an even amount of boys and girls, 13 and 11, respectively. Third, a trained research assistant measured height (cm) and weight (kg), rather than relying on self-report. Fourth, physical activity and sedentary behavior were objectively measured using accelerometers. Last, when the children chose their snack, they were placed in a room by themselves, so there wasn't any bias influencing what snack they chose. Potential limitations included siblings participating in the study and sample size. There could be a bias with participants who were from the same family. The participants could potentially talk after they went home about their snack choices. This could possibly be influential on their choices when they come in for the next session. However, we do not have evidence of this. Secondly, this was a pilot study that is why sample size was small.

Conclusion

In conclusion, there was no statistical significance between the three conditions on snack choice. However, there was a trend ($p=0.06$) for children choosing an unhealthy snack choice after sedentary activity. Children who are sedentary choose unhealthy snack options increasing their energy intake without increasing their energy

expenditure leading them to a positive energy balance. This could potentially lead to children gaining weight over time. Our findings suggest overweight/obese children tend to choose healthier snack options after a 60 minute bout of PA. Promoting physical activity to children who are overweight/obese could potentially lead to losing weight overtime by decreasing energy intake and increasing energy expenditure. The results of this study could potentially influence obesity intervention programs by placing more emphasis on healthier snack options immediately following PA sessions. Future studies should look at incorporating larger sample sizes with the majority of the children potentially being overweight/obese. This could further our understanding on children's snack preferences after different activities to help control excess caloric intake to prevent children from gaining additional weight. Future studies could also examine what influences children's snack choice outside of the home.

APPENDICES

APPENDIX A
MEASURES

CHILD HEIGHT AND WEIGHT data sheet

Child ID:_____ Child Gender: M F

Date:_____

Weight Data (in kilograms to 0.1 kg):

MEASURE 1 _____ kg

MEASURE 2 _____ kg

MEASURE 3 _____ kg

HEIGHT Data (in centimeters to 0.5 cm):

MEASURE 1 _____ cm

MEASURE 2 _____ cm

MEASURE 3 _____ cm

APPENDIX B
FLIER

Healthy Volunteers Needed

Researchers at the University of North Dakota
Department of Kinesiology and Public Health
are seeking healthy **children (aged 9-13 years)** to examine child activities.

What you will do: Child will attend **three one-hour sessions** and have different activities to participate in for each session.

What to wear: Please wear athletic shoes and comfortable clothes (shorts, sweats, t-shirts, etc)

When: Whatever suits your availability (December – April)

Compensation: **$30 for kids $20 for adults**

For More Information Contact:
Allison Barry
Phone # **(701) 777-2951**

Child research study
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APPENDIX C
CHILD PERMISSION FORM

Child Permission Form

Project Title: **Effect of Sedentary and Physical Activities on Children's food choice**

Principle Investigator: Allison Barry

Advisor: Tanis Hastmann, PhD, MPH

A person who is to participate in the research must give his or her informed consent to such participation. This consent must be based on an understanding of the nature and risks of the research. This document provides information that is important for this understanding. Research projects include only subjects who choose to take part. Please take your time in making your decision as to whether to participate. If you have questions at any time, please ask.

Your child is invited to participate in a research study about child activities and food choice. The purpose of this research is to find out whether a child's physical activity will influence a child's food choice right after the activity. Your child will have activity measured via accelerometer, which is a small device that measures your activity. We are trying to find out if the amount of activity will change your child's food choice.

If you want your child to be in this study, we will ask him/her to do the following things:

1. On the *first session*, **YOU WILL:**
   - Take a short survey on fruits, vegetables, sedentary and physical activities available for your child in your home.

2. On the *first session*, **YOUR CHILD** will:
   - Have his/her height and weight measured in a private setting.
   - Sit for 60 minutes watching movies or TV shows.
   - Pick what type of snack they want to eat (chocolate, chips, fruit and vegetables).

3. On the *second session*, **YOUR CHILD** will:
   - For 60 minutes, participate in activities such as: hockey, kickball, sprints, wheel barrel races, crab walks, grape vine, bear crawl, jump rope, hula-hoop, jumping jacks, and scooter races.
   - Pick what type of snack they want to eat (chocolate, chips, fruit and vegetables).

4. On the *third session*, **YOUR CHILD** will:
   - Sit for 45 minutes watching movies or TV shows and participate in sprints, wheel barrel races, crab walks, grape vine, bear crawl, jump rope, hula-hoop, jumping jacks, and scooter races for 15 minutes.
   - Pick what type of snack they want to eat (chocolate, chips, fruit and vegetables).

(Children will be randomized into these conditions, so not every child will receive this exact order of conditions.)

We want to tell you about some things that may happen to your child if you choose to let him/her participate.

Participation and Confidentiality

Participating in the study is voluntary. All of your and your child's information that will be collected is confidential and no one else will know except you and the researcher. When we are done with the study, we will write a report about what we found out. We will not use your name or your child's name in the report. Your child may choose to withdraw at any time during the study. Your decision whether or not to participate will not affect your or your child's current or future relations with the University of North Dakota.

Potential benefits and concerns

There is a chance that your child might feel uncomfortable when we measure height or weight. Your child may experience dizziness or get tried while doing the activities, but he/she can stop participating in the activities when he/she wants to.

What does my child benefit from this study?

Not everyone who is in this study will benefit. We hope your child will enjoy the activities and food choices. What we learn may give us an idea as to what snacks children chose after certain activities.

Questions/comments? This project was approved by the Institutional Review Board at the University of North Dakota (701-777-4279); they will be able to answer any question you have about your rights when participating in this study. If you have any other question about this study please feel free to contact Dr. Tanis Hastmann (701-777-2994) Allison Barry (701-777-2951).

If you want your child to be in this study, please sign your name.

_____

Print Your name

_____ _____

Sign Your name Date

Do you allow your child to participate in this study?

☐ Yes ☐ No

APPENDIX D
CHILD ASSENT FORM

Child Assent Form

Project Title: **Effects of Sedentary and Physical Activities on Child's Food Choice**
Principle Investigator: Allison Barry
Advisor: Tanis Hastmann, PhD, MPH

We are doing a research study; a research study is a special way to find out about something. You are invited to be in a research study about various activities and food choice. The purpose of this study is to find out whether your different activities will impact your food choices. You will wear a small device on your arm that measures activities. We are trying to find out how much activity you are doing when you are playing the various activities.

If you want to be in this study, we will ask you to do the following things:

1. On the first session, you will:
   - Have your height and weight measured in a private setting.
   - Sit for 60 minutes watching movies or TV shows.
   - Pick one of four snacks (chocolate, chips, fruit, vegetables).

2. On the second session, you will:
   - Participate in activities such as: hockey, kickball, sprints, wheel barrel races, crab walks, grape vine, bear crawl, jump rope, hula-hoop, jumping jacks, and scooter races for 60 minutes.
   - Pick one of four snacks (chocolate, chips, fruit, vegetables).

3. On the third session, you will:
   - Sit for 45 minutes watching movies or TV shows and participate in sprints, wheel barrel races, crab walks, grape vine, bear crawl, jump rope, hula-hoop, jumping jacks, and scooter races for 15 minutes.
   - Pick one of four snacks (chocolate, chips, fruit, vegetables).

(Children will be randomized into these conditions, so not every child will receive this exact order of conditions.)

We want to tell you about some things that may happen to you if you choose to participate.

Participation and Confidentiality (will not be shown to anyone else)

Participating in this study is voluntary, meaning it is up to you. All of your information that will be collected will not be shown to anyone else and no one else will know except you and the researchers. When we are done with the study, we will write a report about what we found out. We will not use your name in the report.

Are there any bad things that might happen during the study?

There is a chance that you might feel uncomfortable when we measure your height and weight. You may experience dizziness or get tired while doing the activities, but you can stop playing the activities when you want to.

What do I benefit from this study?

Not everyone who is in this study will benefit. A benefit means that something good will happen to you. We hope you will enjoy the activities and food choices. What we want to learn will help us understand what kind of snacks you like after different activities.

What if I don't want to do these activities?

You do not have to be in this study. It is up to you. If you do not want to be in this study or if you say you want to change your mind that is OK. No one will be mad, including the researchers, your parent, and the University of North Dakota if you don't want to do it.

If you want to be in this study, please sign your name.

_____ _____

Your name Date

APPENDIX E
PHOTO RELEASE

Child Food Choice Study Photo Release Form

I give my consent for my child to be photographed during TV and physical activity conditions during this study and for his/her picture to be used for public purposes (public presentations at conferences and power point presentations of this project). Your child's name will not be attached to the pictures for public purposes.

O YES
O NO

Child's Name: _____

Parent/Guardian's Name (Printed): _____

Parent/Guardian Signature: _____ Date: _____

APPENDIX F
PARENT SURVEY

Parent Survey

Child Name: _____
(Last Name) (First Name)

Child Age: _____ **years**

Child Date of Birth: _____/_____/_____
(month / date / year)

Parent Name: _____
(Last Name) (First Name)

This cover sheet will be torn off by the researchers so that your name will NOT be on the questionnaire.

INSTRUCTIONS:

Please read all of the instructions and questions carefully.

Do not put your name on any part of the survey on the following pages.

Fill in the circle next to each question that indicates your best answer. Some questions have a blank space for you to write your answer.

When referring to your child, please refer to your **9-13 year old child**.

This is not a test, so there are no right or wrong answers. If you do not find an answer that fits exactly, use the one that is closest.

A. What foods do you have in your home?

1. Did you have each of the following Foods in your **home in the last week?**
(Please check the "YES" or "NO" circle)

	100% Fruit Juice & Fruit	Yes	No		100% Fruit Juice & Fruit	Yes	No
a.	100% Orange Juice	O	O	b.	Kiwi	O	O
c.	100% Apple Juice	O	O	d.	Strawberries	O	O
e.	100% Grape Juice	O	O	f.	Pineapple	O	O
g.	Other 100% Juice	O	O	h.	Grapefruit	O	O
i.	Bananas	O	O	j.	Fruit salad	O	O
k.	Apples	O	O	l.	Applesauce	O	O
m.	Cantaloupe	O	O	n.	Watermelon	O	O
o.	Grapes	O	O	p.	Raisins	O	O
q.	Oranges	O	O	r.	Dried fruit	O	O
s.	Pears	O	O	t.	Peaches	O	O
u.	Plums	O	O	v.	Other fruit	O	O
w.	Chips (potato, tortilla, corn)	O	O	x.	Popcorn	O	O
y.	Nuts	O	O	z.	Chocolate	O	O
aa.	Cookies	O	O	bb.	Candy (non-chocolate)	O	O

Survey continues →

2. Did you have each of the following **Vegetables** in your **home in the last week?**
(Please check the "YES" or "NO" circle)

	Vegetables	Yes	No		Vegetables	Yes	No
a.	Carrots	O	O	b.	Broccoli	O	O
c.	Celery	O	O	d.	Lettuce	O	O
e.	Greens (Spinach, Kale, Collard, Turnip)	O	O	f.	Green Beans	O	O
g.	French fried potatoes	O	O	h.	Cole slaw	O	O
i.	Potato salad	O	O	j.	Cooked beans (pinto, black-eyed peas, pork n')	O	O
k.	Other white potatoes	O	O	l.	Sweet potatoes	O	O
m.	Corn	O	O	n.	Cabbage	O	O
o.	Green peas	O	O	p.	Okra	O	O
q.	Tomatoes	O	O	r.	Cauliflower	O	O

3. Did you have each of the following **Physical Activity equipment** in your **home in the last week?**
(Please check the "YES" or "NO" circle)

	Equipment	Yes	No		Equipment	Yes	No
a.	Inside playroom	O	O	b.	Exercise room/equipment	O	O
c.	Sandbox	O	O	d.	Driveway	O	O
e.	Outdoor play area / yard	O	O	f.	Bicycle	O	O
g.	Swing set	O	O	h.	Rollerblades/skates	O	O
i.	Skateboard/scooter	O	O	j.	Jump rope	O	O
k.	Hula Hoop	O	O	l.	Running shoes	O	O
m.	Basketball equipment	O	O	n.	Hockey equipment	O	O
o.	Balls	O	O	p.	Yoga mat	O	O
q.	Racket	O	O	r.	Exercise videos	O	O
s.	Baseball equipment	O	O	t.	Boxing equipment	O	O

Survey continues →

4. Do you have the following items **in your Home** and in the **Child's bedroom**?

		Home		Child's Bedroom	
a.	Television	O Yes	O No	O Yes	O No
b.	Cable	O Yes	O No	O Yes	O No
c.	Digital Video Recorder / TiVO	O Yes	O No	O Yes	O No
d.	DVD Player	O Yes	O No	O Yes	O No
e.	Computer	O Yes	O No	O Yes	O No
f.	Internet	O Yes	O No	O Yes	O No
g.	Video Game Systems (Nintendo DS, Playstation, X-Box, Wii)	O Yes	O No	O Yes	O No

5. Number of working Televisions in your home: _____

B. Information about YOUR CHILD'S Activities

Instructions: For the following two questions, think about all the time your child spends in physical activity each day. Do not include physical education or gym class. Add up the total time your child spend in physical activity and select the most accurate response for each question below. **Physical Activity is any play, game, sport, or exercise that gets your moving and breathing harder.**

	0 days	1 days	2 days	3 days	4 days	5 days	6 days	7 days
6. Over the <u>past 7 days</u>, on how many days was **your child** physically active for a total of at least <u>60 minutes</u> per day	☐	☐	☐	☐	☐	☐	☐	☐
7. Over a <u>typical or usual week</u>, on how many days was **your child** physically active for a total of at least <u>60 minutes</u> per day	☐	☐	☐	☐	☐	☐	☐	☐

Survey continues →

YESTERDAY (All day long) – How much time did YOUR CHILD spend…

	None	15 min or less	30 min	1 hour	2 hours	3 hours	4 hours	5 hours	6 hours or more
8. Watching television (not including videos on a VCR or DVD player)	O	O	O	O	O	O	O	O	O
9. Watching movies or videos on a VCR or DVD player	O	O	O	O	O	O	O	O	O
10. Playing video games (like Wii, Leapster, Playstation, Nintendo DS)	O	O	O	O	O	O	O	O	O
11. Playing on a computer	O	O	O	O	O	O	O	O	O

LAST SATURDAY (All day long) – How much time did YOUR CHILD spend…

	None	15 min or less	30 min	1 hour	2 hours	3 hours	4 hours	5 hours	6 hours or more
12. Watching television (not including videos on a VCR or DVD player)	O	O	O	O	O	O	O	O	O
13. Watching movies or videos on a VCR or DVD player	O	O	O	O	O	O	O	O	O
14. Playing video games (like Wii, Leapster, Playstation, Nintendo DS)	O	O	O	O	O	O	O	O	O
15. Playing on a computer	O	O	O	O	O	O	O	O	O

Survey continues →

C. Information about YOUR foods

A serving of <u>fruit</u> is equal to:

- 1 medium piece of fresh fruit
- ½ cup of fruit salad
- ¼ cup of raisins, apricots, or other dried fruit
- 6 oz of 100% orange, apple or grape juice

(Do not count fruit punch, lemonade, Gatorade, Sunny Delight or any other

A serving of <u>vegetables</u> is equal to:

- 1 medium carrot or other fresh vegetable
- 1 small bowl of green salad
- ½ cup of fresh or cooked vegetables
- ¾ cup of vegetable soup

D. Information about YOUR CHILD'S foods

16. How many servings of **fruit** does your child **usually** eat each day?

    _____ Servings per day

17. How many servings of **vegetables** does your child **usually** eat each day?

    _____ Servings per day

18. How **often** does **YOUR CHILD** eat take-out or fast-food? (e.g., hamburgers, chicken nuggets, French fries, hot dogs, pizza)
    - O Less than once per month
    - O 1 – 3 times per month
    - O Once per week
    - O 2 – 4 times per week
    - O 5 – 6 times per week
    - O Once per day
    - O 2 or more times per day

E. Parent (Caregiver) Demographics

19. I am the child's:
    - O Mother (Female Caregiver)
    - O Father (Male Caregiver

20. I am currently:
    - O Married
    - O Divorced or separated
    - O Widowed
    - O Single

Survey continues →

21. **I describe my family as**: (Select one or more for each)

	Parent (Caregiver)	Child
American Indian or Alaska Native	O	O
Asian	O	O
Black or African American	O	O
Hispanic or Latino	O	O
Native Hawaiian or Other Pacific Islander	O	O
White	O	O
Don't know/not sure	O	O
Prefer not to answer	O	O

22. **Highest level of education** completed for child's parents or adult caregiver's:

	Mother (female caregiver)	Father (male caregiver)
Less than high school	O	O
High school	O	O
Some college or associates degree	O	O
Graduated college	O	O
Master's degree or above	O	O
Does not apply	O	O

23. My age (Parent/Caregiver): _____

24. Is your child eligible to receive breakfast or lunch for free or at a reduced cost? (mark one)
    - O Yes
    - O No
    - O Prefer not to answer

Finished - Thank you for your participation!

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