1-1-2014

Metabolic Health and Academic Achievement in At Risk Youth Participating in Studio Based Summer Camp

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Metabolic health and academic achievement in at risk youth participating in studio based summer camp

By

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A Thesis
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in Kinesiology
in the Department of Kinesiology

Mississippi State, Mississippi

May 2014

Metabolic health and academic achievement in at risk youth participating in studio based summer camp

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Title of Study: Metabolic health and academic achievement in at risk youth participating in studio based summer camp

Pages in Study: 62

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Childhood obesity and subsequent poor health implications continue to be a critical health concern and recent literature suggests academics may also be under greater strain among these individuals. This study examined the relationship between metabolic health and academic achievement in students "at risk" for drop. Fifteen adolescences participated in an educational camp aimed at developing knowledge of core curriculum by developing design projects. Metabolic health was assessed via biochemical measurements of blood lipid and glucose, resting blood pressure, and anthropometric measurements of height, weight, and waist circumference. Variables were examined individually and as a combined risk score. Academic achievement measurements were results were obtained from district testing. Little association was found between academic achievement and metabolic health. BMI was greater than the 85th percentile for sample. Participants partook in 32.4 minutes/day of moderate-vigorous physical activity during camp. Slight variation between Pre-and Post- measures of academics suggests presence of confounding variables.

DEDICATION

Up until this point the dedication would have flowed onto the page with words of praise and gratitude about the people that have pushed me toward the finish line as I kicked and screamed the whole time. Now that this long and difficult journey is coming to an end, I have seemed to have blacked out all of the tears, complaints, and moments of anxiety that I forced upon my support system; although, I am sure that they haven't forgotten those frequent moments. This project is dedicated to those people that have loved and stood by me from afar; specifically my parents Lonnie and Susan, my sister Neely, my Nanny and Bruce, my boyfriend Kevin, the Blakely's, Stringer's, Gaston's and my close circle of friends, Micalea, Olivia, Bridget, Kelsi, Erin, Stephanie, and Logan. Thank you for staying up late to listen to me complain and steering me into the right direction along the way. Without your wise words and genuine support none of this would be possible.

ACKNOWLEDGEMENTS

This body of work would not have been possible without my committee members, colleagues, and Mississippi family. To my committee members that have challenged my mind continually throughout the past two years, thank you for letting me be a part of Studio School and for pushing me to go further. Although our journey is coming to a close you have taught me more than you will ever know. Mississippi State will always hold a special place in my life's journey.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Approximately 25.5% of Mississippi's population is under the age of eighteen and of that, 16.5% of that youth were considered overweight and 15.8% were considered obese. This is significantly higher than the national average 15.2% overweight youth and 13.0% obese adolescents (YBRSS CDC, 2011). These prevalence estimates are determined using the Youth Risk Behavior Survey surveillance system. The survey is given annually to high school students in all fifty states and allows students to anonymously complete a self-reported questionnaire on lifestyle behaviors, and anthropometric measurements according to Center of Disease and Control (CDC) criteria. From selected answers body mass index (BMI) was calculated through the equation: BMI = kg/m^2 = Weight (in kilograms)/ [Height (in meters)^2]. The CDC criteria obesity classification is determined by students who reported their height and weight at greater than or equal to the 95th percentile for body mass index, based on sex- and age-specific criteria. Overweight is determined by youth who reported their height and weight greater than 85th percentile but less than the 95th percentile for body mass index, based on sex- and age-specific reference data from the 2000 CDC growth charts (MMRW, 2012). Furthermore, the most recent data suggest the majority of Mississippi youth do not meet the 2008 Physical Activity guidelines of participating in at least 60 minutes of physical activity that increased heart rate or increased breathing frequency on any day before the survey (YBRSS CDC, 2011). The YBRSS found that 18.0% of Mississippi's youth had not been active for at least sixty minutes per day on less than five days before the survey was taken (YBRSS CDC, 2011). Physical activity was assessed by doing any kind of movement that increases heart rate and increases oxygen consumption. Obesity is considered a public health crisis that is anticipated to affect obese children into adulthood. Obese children are carrying negative health implications that are associated with cardiovascular disease into adulthood. Obese children are at a greater risk for developing metabolic syndrome and cardiovascular disease (Serap, Mevlut, Inanc, & Ender, 2007). Risk factors for metabolic syndrome that include hypertension, insulin resistance, increased waist circumference, high triglycerides, and increased fasting glucose levels (Eisenmann, Lauron, DuBose, Smith, & Donnelly, 2010; Serap et al, 2007; Stong, Malina, Blike, Daniels, Dishman, Gutin,…& Trudeau, 2006). Metabolic syndrome significantly increases the child's risk for developing CVD, which can promote the development of premature atherosclerosis and can lead to an increased risk of having a heart attack or stroke (Jago, Froberg, Cooper, Eliberg, & Anderson, 2010). Obesity is affecting the youth's health and recent literature suggests that their education may also be affected.

Recently, researchers have begun to examine the effects of negative health disparities on the learning process and have suggested that the same populations are affected by both a widening achievement gap and health disparities, like metabolic syndrome. Research suggests that healthier students make for better learners. Factors affecting the child's ability to learn can be broken down into subcategories that play an essential role in academic achievement: family, social, physical, and economic environment. (Basch, 2011; Strong et al., 2006). For example the student that gets more than eight hours of sleep a night, eats a well-balanced breakfast, and participates in regular physical activity will increase the child's ability to learn. Students with poor academic achievement are at an increased rate for behavioral problems and may be more likely to drop out of school before the completion of graduation. Other environmental factors of decreased academic performance include lack of family support, frequent absences, or not reaching full academic potential (Basch, 2011). Basch goes on to state, that beyond the child's individual personality characteristics educationally relevant health disparities, such as metabolic syndrome, can influential the role in shaping educational and social lives of children, more specially urban minority youth (Basch, 2011; Strong et al., 2006).

Childhood obesity may expand waist lines and widen the achievement gap. The purpose of this Thesis will be to examine the relationship between physical activity, metabolic syndrome variables, and academic achievement in students who are at risk for drop out. Specifically, this Thesis will describe the relationships between health disparities and academic disparities and the potential role that physical activity may play on these relationships. It is hypothesized that there will be a positive correlation between poor metabolic health and adverse academic achievement.

CHAPTER II

REVIEW OF LITERATURE

We are expanding as a nation. Not only are children being born at alarming rates, but they are also coming out at an alarming size. Childhood obesity has more than doubled since 1980 and recent studies conducted by the government states that it is only growing (MMWR, 2012). One day, children will grow and mature into adulthood. Components of childhood obesity such as increased adiposity may stay with the child, which tends to increase the risk of adult obesity (Whitker, Pepe, Wright, Seidel, & Dietz, 1998; Rolland-Cachera, Deheeger, Bellisle, Sempe, Guilloud-Bataille, & Patois, 1984; Strong et al., 2006). The operational definition of obesity is a lack of energy balance, which is to say that there are a greater number of calories that are consumed than calories that are expended (Tompkins, Hopkins, Goddard & Brock, 2012). Multiple factors influence childhood obesity including social and metabolic factors (Holmes, Ekkekakis, & Eisenmann, 2009; Basch, b, 2011). Researchers are only able to speculate the direct causes, prevention and treatment of childhood obesity. This literature review will examine obesity parameters and various ways to classify obesity. As obese individuals grow into adulthood, obesity has many negative health implications concerning metabolic syndrome and overall cardiovascular health. Obesity may also negatively affect academic achievement and social wellbeing (Basch, 2011). The purpose of this literature review is to explore metabolic syndrome parameters, physical activity and academic achievement in youth.

Childhood obesity

A single, direct cause of obesity has yet to be identified; causal elements range from the individuals' genetic code to their lifestyle (Holmes, Ekkekakis, & Eisenmann, 2009). Some researchers suggest that childhood obesity is preventable, while others suggest that we can only prevent part of the problem (Serap et al., 2007; Holmes, et al., 2009). For example, recent studies have suggested that the total energy expenditure is more significant than actual weight gain (Jago et al., 2010). Increasing total energy expenditure may translate into developing healthy lifestyle habits in the form of increased physical activity and proper dietary food selection. Holmes et al. have combined physical activity, stress, and metabolic syndrome to form a triad to create awareness of components other than just energy intake and expenditure (Holmes, et al., 2009). Currently, there is not direct cause of obesity, research is still developing hypotheses for causal elements ranging from genetic code to the balance of energy expenditure and energy intake.

Obesity does not have continuity throughout all the different ethnicities, genders, and ages; however, childhood obesity can be standardized through characterization. Childhood obesity is defined through an age and sex specific percentile for body mass index (BMI). As a reference point, height is compared to weight in kilograms to comprise CDC growth charts for children ages two to nineteen. Overweight is defined as a BMI calculated at or above the eighty fifth percentile but below the ninety fifth percentile based on children at their same age and sex (MMWR, 2012). Obese is defined as a BMI greater than or equal to the ninety fifth percentile based on their peers of the same age and sex (MMWR, 2012).

Markers of Growth and Maturation

Although set definitions on a child's weight status have been established, research must be able to differentiate between the child's natural growth, or maturation and chronological age, or biological age. Maturation refers to the individuals' progress toward their adult state while growth refers to a change their dimensions (Baxter-Jones, Eisenmann, & Sherar, 2005). Development of cognition and behavioral social norms are also occurring simultaneously with growth and maturation (Rogol, Roemmich, & Clark, 2002). For example, children that are involved in regular physical activity in the form of youth sports may be establishing exercise habits that will shape their activities as adults. If an individual has always valued physical activity, they may be more likely to be more physically active later on in life. Physical activity during childhood will also effect body composition and adiposity during growth and maturation. As children grow they increase muscle mass and fat mass. Organs increase at a different rate than their height which increases at a different rate than their weight. Children at the same chronological age may differ significantly in biological age from their peers (Baxter-Jones et al., 2005).

Biological maturation is tracked by the parameters of timing of the specific maturation events and the speed at which these events occur. Skeletal age is a marker of bone growth and biological maturation that can be plotted again chronological age and spans throughout the child's entire growth period (Baxter-Jones et al., 2005). Usually measured through hand x-ray, individual with more visible cartilage are considered to be a less mature than someone with greater bone development. Peak height velocity (PHV) also accounts for biological maturation by marking the specific age of maximum velocity in stature growth (Baxter-Jones et al., 2005). Age at PHV is defined as the age at which the maximum velocity of growth is occurring and is measured by plotting a human growth curve of height in centimeters against age in years (Baxter-Jones et al., 2005). Because this event occurs in both boys and girls, PHV can provide a puberty identification landmark for both genders. Allowing for gender comparisons, females tend to reach their peak height earlier than males, 12 years old to 14 years old, respectfully. Because PHV is a less invasive measure of biological maturation as opposed to assessment of pubic hair, PHV is used for categorical placement of early, average, and late matures. Youth who reach PHV a year or more before the mean ages of PHV are early matures, compared to late maturers who reach PHV (Baxter-Jones et al., 2002). When documented on the growth height velocity curve, it is suggested that individuals experience the greatest rate of growth during the first few years of life and then again during puberty. The second increase in development marks the adolescent growth spurt and PHV.

Adiposity increases within the individuals first year of life due to the progression in size of the adipocyte cells, however for the next couple of years the cell size remains stable and the child’s height increases. The second stage is classified as the adiposity rebound (AR), in which both adipocyte cell size and number rapidly increase, suggesting hyperplasia (Rolland-Cachera, Deheeger, Bellisle, Sempe, Guilloud-Bataille, & Patois, 1984). Following AR individuals gradually biologically mature into adulthood. The onset of AR is usually marked at or around the chronological age of 6. Clinically significant, research suggests that AR may be predicative of future obesity (Rolland-

Cachera et al., 1984; Whitaker, Pepe, Wright, Seidel, & Deitz, 1998). Rolland-Cachera et al. found that an earlier AR was followed by an increased level in adiposity as opposed to a later rebound that was associated with a decreased level in adiposity. Again, individuals may be able to be classified as early, average, and late. Females tend to reach AR sooner than males, marking girls for an increased risk for carrying obesity into adulthood (Whitaker et al., 1998). However, in both sexes, individuals that reached AR sooner, had a higher BMI at AR, and whose parents also had higher BMI's were more likely to carry obesity into young adult (Whitaker et al., 1998). Combined with inherited genetics, AR may be difficult to change in the prevention of obesity.

Puberty

Secondary sex characteristics as defined by Tanner, outlines sexual maturation for both genders. Females sex characteristics are defined through breast and pubic hair development while males are defined by genitalia and pubic hair development (Tanner, 1962). Great individualization occurs within the development of secondary sex characterizes. Pubertal events, such as facial hair in males or menarche in females, occur under endocrine control and vary within Tanner's stages (Tanner, 1962 ; Baxter- Jones et al., 2005). To account for maturation by comparing secondary sex characteristics, visual evidence supports females entering puberty before males and that pubertal events do not occur in the same order. The timing and tempo of sexual maturation and biological maturity is different for males and females (Baxter-Jones et al., 2005). PHV in females corresponds to pubic hair stages 3 or 4, whereas in males PHV usually occurs during pubic hair stages 4 or 5 (Baxter-Jones et al., 2005).

Generally adolescents' development varies from individual to individual and can be characterized by the tempo and growth of each distinct system: skeletal, reproductive, and somatic (Rogol et al., 2002). Secondary sex characteristics utilize endocrine function and pubertal events to gage an individual's progression from adolescents to adulthood, and although clinically significant, a less invasive method will be used for research purposes to account for gender comparisons (Baxter-Jones et al., 2005). More relevant, PHV allows for predications on that child's growth and maturation and also accounts for gender and age related differences. The gradual transition from childhood to adulthood is termed puberty. The body undergoes dynamic changes that are marked by the adolescent growth spurt and the redistribution of body fat. Rapid changes are occurring in body dimension, silhouette, and composition (Rogol et al., 2002). During this time, increasing neuroendocrine axis function regulates gonadotropin hormones like leptin, sex-steroids, and growth hormone (GH) (Rogol et al., 2002). It has been suggested that interactions between axes are more dependent on the signaling pathways from the alterations in body composition, size, and shape than of the hormones concentrations themselves (Rogol et al., 2002). During somatic growth the body is stimulated by nutritional, genetic, and hormonal factors. Genetic contributions to the child's adult size tend to vary with environmental factors like parents BMI or industrialization state of the country (Rogol et al., 2002; Whitaker et al., 1998).

Nutritional intake "is the single most important cause of [nutrition] retardation world wide…" (Rogol et al., 2002). Physiologically increases in free fat mass and the development of muscle mass require essential nutrients for proper development. Calcium is not only critical to force production through muscle contraction, but it is also required for bone and teeth growth. Without proper and adequate nutrition, growth and maturation are adversely effected and in turn can be delayed. Malnourished children tend to mature earlier than their overweight peers (Rogol et al., 2002). During pubertal growth an increase in height is also accompanied with an increase in weight, specifically in the hydration of fat free mass (FFM). As the tissues become more metabolically active during the pubertal growth spurt there is a greater degree of hydration and thus promotion of FFM. During puberty males acquire more FFM for a greater duration of time particularly due to increases in testosterone while females increase in fat mass and body fat primarily due to increases in androgen and estrogen (Rogol et al., 2002). The distribution of fat generally results in the android shape for men and gynoid pattern for females.

Risk factors associated with health disparities that are present in adulthood may appear during childhood. At the time of puberty, a dynamic change in growth for adolescents is marked by changes in weight, height, and overall body composition. Such anthropometric changes may affect the appearance of premature disease. Factors inducing and promoting puberty include the stimulation of hormones, nutrition, and heredity that may play a direct role on childhood obesity and prevalence rates.

Metabolic Syndrome and Cardiovascular Disease Risk

A complex and widening issue, childhood obesity seems to be supporting the onset of Metabolic syndrome (MeTs), or insulin resistance syndrome. MeTs processes similar symptoms as to those found in cardiovascular disease (CVD) like increased visceral fat or hypertension; children that are obese are at an increased risk for developing both MeTs, CVD, and type two diabetes (Eisenmann, Laurson, DuBose, Smith, &

Donnelly, 2010; Esienmann, 2008). Due to the low prevalence, one causal element has yet to be identified for MeTs suggesting that all factors may influence and be dependent on each other. Previous research has been conducted with small sample sizes are not representative of the population, thus sample means are not large enough to encompass all of the components of metabolic syndrome. (Eisenmann, 2008). Researchers have compiled common variables to create a continuous scale to from a composite score, or Z-score, to represent the child's CVD risk factor profile (Eisenmann et al., 2010; Esienmann, 2008). Regression on to age allows researchers to account for the influence of maturity status on the composite scores. (Eisenmann et al., 2010; Esienmann, 2008). Multiple Z-scores can be used to standardize for gender and ethnicity, because each metabolic syndrome variable is regressed onto the independent variable of, age, sex, or ethnicity. (Eisenmann et al., 2010; Esienmann, 2008).

A Z-score is composed of waist circumference (WC), blood pressure (BP), fasting glucose, triglycerides and lowered HDL-cholesterol (Eisenmann, 2008; Strong et al., 2006). All of the individual risk factors for the Z-score criteria are then complied, because high-density lipoprotein-cholesterol (HDL) is considered a maker of positive health, it is inversely related to the Z-score. The higher the composite score the greater the health disparities (Eisenmann, 2008). The clustering of CVD risk factors and the devising of MeTs has further stratified at risk obese children and estimated that 10-20% of obese children have a comorbidity with MeTs (Eisenmann et al., 2010). Recent research has evaluated obese children based on blood pressure, and biochemical cardiovascular risk factors, then compared measurements to non-obese peers. Hypertension was found to be the most prevalent risk factor associated with MeTs in obese youth (Eisenmann, 2008). Arguably, hypertension may be the most preventive factor through diet and physical activity. Data suggest that an intervention of 30 minutes, three times a week at 80% maximal heart rate can reduce blood pressure in hypertensive youth (Strong et al., 2006). MeTs in childhood tends to promote the development of premature hardening of the arteries and significantly increases the individuals CVD risk later on in their life (Searp et al., 2007). The origin of CVD in adulthood is likely to start in childhood. There was a 2.1% prevalence of MeTs in obese children compared to non-obese children and of that prevalence, over 79% of obese children had at least one MeTs risk factor (Searp et al., 2007). Eisenmann et al. did not find one child that possessed all five MeTs risk factors and inferred that there is not gender prevalence associated with MeTs (Eisenmann, 2008). Obese children were found to be hypertensive, have an increased sensitivity to insulin, and had higher triglycerides (specifically, high LDL and low HDL) compared to the control group (Searp et al., 2007). Based on the current criteria of MeTs through a Z-composite score, trends show that overweight or obese individuals encompass a greater number of risk factors at a higher severity than their peers (Eisenmann, 2008; Searp et al., 2007).

Endocrine Function

Elevated hormonal responses in obese populations, especially correlations between morning cortisol levels and adipose tissue, have been speculated as a causal element for obesity prevalence. Increased cortisol levels are stimulated by increased hypothalamic-pituitary-adrenal axis activity (HPA). Increased sympathetic nervous system (SNS) response and HPA activity are indicators of physiological stress. Individuals in improvised conditions such as low socioeconomic status tend to be more acceptable to stress (Holmes et al., 2009). Increased activity may lead to amplified adipose tissue in the abdominal region. In a longitudinal study conducted by Hill et al. it was suggested that elevated morning cortisol levels do increase the risk of developing high adipose tissue to a certain point, then once past or at that point the effects of cortisol on adipose tissue are narrowed (Hill, Eisenmann, Gentile, Holmes, & Walsh, 2011). This may be attributed to the body's ability to protect itself as an adaptive response from developing type II diabetes and metabolic syndrome, specially insulin resistance (Hill et al., 2011). Over a nine month period, the study concluded that there was a positive correlation between waist circumference, abdominal adipose tissue, and morning cortisol levels in obese adolescents (Hill et al., 2011). Cortisol stimulates the mobilization of free fatty acids for lipolysis and regulates blood glucose during exercise. Chronically high levels of cortisol result in the down regulation of receptors due to the increased stimulation from the pancreas to secrete insulin. Increased levels of cortisol may make the body less sensitive to insulin and thus increasing ones lack of glycemic control. Holmes et al. suggest that cortisol has a stimulatory effect on impaired feedback, thus copying insulin resistance and increasing buildup of plaque within the arteries (Holmes, 2009). Evidence has shown that exercise training can positively impact the person's well-being by improving insulin sensitivity by glycemic control (Lee, Song, Kim, Lee, Jeong, Suh, …& Hong, 2010).This metabolic response, lack of glycemic control, can increase the risk of developing type II diabetes and support MeTs development.

Cardiovascular Function

The origin of adult CVD begins during childhood. Lifestyle diseases that cause decreased arterial compliance or an increase plaque in the arterial walls start in early adolescence and continue into adulthood. Heredity, specifically paternal blood pressure (BP), plays a key role in the clustering of CVD risk factors. Children with hypertensive parents are more likely to have increased BP and have an increased risk for the develop hypertension in adulthood (Esienmann, 2008; Burke, 2006). Body composition may also directly impact increases in blood pressure, in which effects have been seen in children as early as the age of 1 (Burke, 2006). Children that were considered overweight, compared to their peers, had a range of 2 mmHg to 6 mmHg higher systolic blood pressure (SBP) (Burke, 2006). Suggesting that there is a great pressure placed on the heart when it is in systole.

Atherosclerosis and endothelial dysfunction have been found in obese youth (REF). Clustered with increased adiposity and increased SBP, arterial distensiblity that mostly commonly seen in aging is not becoming apparent in childhood suggesting that decreased distensibility originates in childhood. Previous autopsies completed on 3 year old children showed increased aortic fatty streaks (Burke, 2006). By the age of 15 it is suggested that 15% of the artery is already compromised, marking adolescence a critical period for cardiovascular health (Rodrigues, Abreu, Resende, Goncalves, & Gouvea, 2013). Increased risk for atherosclerosis correlates with adiposity and CVD risk factors increased LDL and decreased HDL (Burke, 2006). It is plausible that obesity may contain a genetic component, because young children would not be able to attain a lifestyle that would accumulate such fatty streaks. A fatty diet with other common CVD risk factors may influence the child's lipid profile during the first few years of life (Rodrigues et al., 2013; Burke, 2006).

The elevation of the ischemic biomarker, High-sensitivity Troponin T (hs-TnT), is commonly seen in adults that have an increased risk for the development of CVD and cardiac dysfunction specifically as a direct indicator and predictor of functional and structural myocardial damage (Pervanidou, Akalestos, Bastaki, Apostolakou, Papassotiriou, & Chrousos, 2013). As opposed to low levels that are almost undetectable in seemingly healthy adults, modest elevation of hs-TnT can indicate an increased risk phenotype for CVD and BMI (Pervanidou et al., 2013). The onset of atherosclerosis may begin in childhood and elevated biomarkers like hs-TnT may be reported in children that are at a high risk for the development of CVD and although ranges have not been established for children, researchers compare ranges of healthy young adults to children (Siervo, Ruggiero, Nutile, Aversano, Iafusco, Vetrano,…& Ciullo, 2012; Pervanidou et al., 2013). Pervanidou et al., found obese children with MeTs had significantly higher levels of hs-TnT than obese children without MeTs and non-obese children, however; all individuals were within normal ranges of healthy young adults (Pervanidou et al., 2013). No significant difference was found between the obese and non-obese population, suggesting that adolescents with MeTs may be at an increased risk for the development of CVD as opposed to adolescents were obese (Pervanidou et al., 2013). Lack of chorionic elevated biomarkers (that are commonly associated with older at-risk adults) within obese children support the absence of cardiac pathologies and propose that an inflammatory response may not cause structural damage in obese children (Siervo et al., 2012). However, the comorbidity with obesity and MeTs presents the belief that those who are obese may be at an increased risk for elevated cardiac biomarkers before the onset of MeTs, increasing the individual's risk for the development of MeTs or CVD.

Preventive measures that increase cardiovascular endurance can create adaptations for future implications. Decreasing adiposity in the form of weight loss can dramatically decrease the likely hood of developing CVD. The detection and prevention of CVD risk factors is critical in adolescents, fatty streaks that begin in childhood are arguably reversible in the early stages of development (Rodrigues et al., 2013). Changes in fitness levels are independent predictors of changes in total cholesterol, blood pressure and visceral android adiposity (Jargo et al., 2012; Lee et al., 2010). Improved fitness level through increasing daily physical activity can positively affect endothelial function and decrease arterial stiffness (Lee et al., 2010). One simple way to diminish CVD risk factors and prevent weight gain is to help the child become more active at a moderate to vigorous intensity level to increase physical well-being.

Lipoprotein-Cholesterol

High cholesterol levels, specifically increased levels of low-density Lipoprotein (LDL) greater than 130 mg/dL and decreased levels of high-density lipoprotein (HDL) below 50mg/ dL, are considered risk factors for both CVD and MeTs (Rodrigues et al., 2013; Strong et al., 2006). Serum lipids are important for maintaining a healthy lifestyle in adulthood and promote positive impacts within childhood. In the presence of plaque build-up in arteries, adolescent's cholesterol levels vary between 140 and 170 mg/dL, suggesting that total plasma cholesterol falls around 150 mg/dL in children (Rodrigues et al., 2013).

Children at or around the age of ten at the 95th percentile have total cholesterol values 15 mg/dL higher than children that are below the age of ten (Cockrell-Skinner, Steiner, Chung, & Perrin, 2012). Children at that age are classified as prepubertal, where chronological age compared to skeletal age shows great variance (Baxter-Jones et al., 2005). Values of serum lipids tend to remain constantly elevated until after adolescents, when the values have been known to decrease slightly only to return to elevated levels after maturation (Kwiterovich & Gidding, 2012). This gives the cholesterol curve a “U” shaped regression. Children at or around the age of 10 have increased serum lipids, which could be attributed to puberty and the great physiological changes that the body is undergoing at that time. Some researchers suggest that there is little change on lipoprotein, specifically increase HDL-C and decreased triglycerides due to physical activity. (Strong et al., 2006). Other researchers suggest that an intervention of 40 minutes per session, 5 sessions a week for at least 4 months may elicit small changes in lipoprotein concentrations (Strong et al., 2006).

During puberty there is increased secretion of Luteinizing hormone (LH) from the anterior pituitary gland that stimulates testosterone and estrogen to promote the growth of secondary sex characteristics. Little research has looked at hormone secretion during prepuberty and lipid levels, especially LDL levels. Increased lipid levels can be indicative of augmented risks for developing more serious conditions. Inversely, decreased lipid levels may improve quality of life for youth, specifically in children that have family hypercholesterolemia (FH). FH has been known to cause premature CVD due to lack of maturation of LDL receptors that cause only partial removal of LDL from the blood, subsequently increasing LDL levels in children (Kwiterovich & Gidding, 2012). Screening children for cholesterol at a young age can better predict not only total cholesterol levels, but also screen for FH. Children that have been diagnosed with FH can have LDL values as high as 240 mg/dL and total cholesterol levels above 300 mg/dL

(Cockrell- Skinner et al., 2012; Kwiterovich & Gidding, 2012). In relation to screening for cholesterol and cholesterol curves, individuals that have FH can skew the data and cause variance within total cholesterol standards. Overall, children with irregular lipid values tend to have irregular lipids into and through adulthood with strong correlations between cholesterol levels and heart disease (Cockrell- Skinner et al., 2012; Rodrigues et al., 2013). Diagnosis and treatment remain at the forefront for screening youth's total cholesterol levels to increase life expectancy and overall quality of health.

Increased TG, greater than 130 mg/dL support the initiation and accumulation of LDL on vessel walls that TG are deposited on, leading to an increased risk for atherosclerosis (Rodrigues et al., 2013). Suggested levels for TG are less than 100 mg/dL. Dislipidemia in childhood has been linked to adiposity, specifically increased TG and decreased HDL was significant lower in obese or overweight 8 year olds (Burke, 2006). If the serum lipid levels are high in early childhood at or greater than 170 mg/dL, for example after the age of two to the age of ten, the American Academy of Pediatrics advises parents to implement lifestyle changes (Cockrell- Skinner et al., 2012). These lifestyle changes can be effective but are hard to maintain, especially with third variables like socioeconomic status and education level. Potential changes include decreased total and saturated dietary fat coinciding with increasing aerobic training to decrease LDL even in the absence of weight loss (Lee et al., 2010). Increasing endurance training positively impacts mitochondrial function, specifically fatty acid oxidation in lipids (Jargo et al., 2010). In diet weight loss alone, there was little change if any in mitochondrial function, suggesting that increasing cardiovascular fitness alone may increase mitochondrial activity by promoting fatty oxidation in lipids (Jargo et al., 2010).

Despite strong evidence that lifestyle modification plays a key role in diminishing risk factors, it is still hard to implement. If lifestyle modification is ineffective after the age of eight some children may be prescribed a statin to maintain serum lipid levels.

Physical Activity and Academic Achievement

Physical activity not only reduces specific metabolic and CVD risk factors like waist circumference and hypertension, but recent studies have drawn correlations between physical activity and improved academic performance. Yet despite this positive correlation, time spent in physical education has not only decreased but in some schools it has been completely removed. The Center for Disease Control and Prevention (CDC) recommend that children complete sixty minutes or more of physical activity a day for seven days a week (CDC, 2012). Observing an elevated heart rate and increased oxygen consumption for at least sixty minutes a day either in structured play inside the classroom or in unstructured play outside of school would meet the CDC guidelines. Since adolescents spend a majority of their time inside the classroom, implementing play into the school day may make the most sense. US Department of Health and Human Services suggest that public schools create a multi-intervention to increase physical activity throughout the seven hour school day (PAGACR, 2008). A multi-component intervention comprises two or more intervention strategies such as, adding short activity breaks to and existing classroom activities throughout the school day and encouraging students during regular scheduled lunch and recess breaks to be more physical active through structured games or activities (PAGACR, 2008).Time spent in moderate to vigorous activity in enhanced physical education courses helps facilitate the government suggested guidelines of sixty minutes of physical activity a day (PAGACR, 2008; Strong et al., 2006).

Public School: Physical Education

A great portion of adolescences are insufficiently sedentary, less than 20% of youth in public schools adhere to the play 60 standard (CDC, 2012; Strong et al., 2006). As children get older, the amount of time that they spend in physical activity whether it is light, moderate, or vigorous, decreases each year (Basch, 2011a; Basch 2011b). Females especially have shown a substantial decline in physical activity from the ages of 8-18 (Dowda, Dishman, Porter, Saunders, & Pate; 2009). Not only are there differences between gender, but also between race. African American and Hispanic youth, again specifically female, are less physically active than white youth (Basch, 2011b).

Since youth spend a majority of their time in the classroom, it makes schools a key target for intervention. Whether it be lack of physical education programs or lack of knowledge of physical educator, there has been a sharp decline in activity. National standards for physical education require that the instructor demonstrate competency in motor skills, understanding of movement, and value physical activity for health (Basch, 2011a). Among other required qualities, there has been little emphasis on the instructor themselves. Rather, school districts have focused on maintaining physical education due to the increased disappearance of programs in public schools. Instructors are in an important position to influence developing youth in both mind and body. In programs, it is critical that educators adhere to the standards set by national physical education committee and provides the students with evidence-based curriculum (Basch, 2011a). Creating a safe and positive environment can foster school connectedness and engagement (Basch, 2011a). Through differentiation, creating multiple activities and options for physical activity may make students more likely to engage in class. Not every student will be able to be a distance runner and some may not have the desire to run at all, but there should always be options. For example if one student does not like to run for competition maybe he or she may be more interested in rollerblading or playing an organized game. Physical education can be either structured or unstructured play, but play none the less.

Unfortunately, many physical education programs are being removed from the curriculum. A decline in physical activity within the school day may be attributed to the schools shift of focus from health education, to reading and mathematics due to the No Child Left Behind Act (NCLB) of 2001. One aim of the NCLB is to eradicate the widening of the achievement gap between minorities and academic barrier whatever it may be (Colquitt, Langdon, Hires, & Pritchard, 2011). There are however, areas for improvement outside of the normal school day. Extracurricular activates, either before or after school, or programs established over extended breaks can greatly influence the child's ability to think critically while becoming more active (Basch, 2011a). It is important that there is time for play even if time cannot be created during the day.

Populations of children that are the least active, also tend to be the students that have greatest disparities in learning. African American females and Mexican American males are the least physically active populations in youth (Basch, 2011b). Targeted at ethnicity, it has been suggested that the achievement gap will not be able to close until all minorities are placed on the same playing field concerning health, specifically within low income minorities from the cities, because lack of academic standards and health discrepancies affect the same populations (Colquitt et al., 2011; Basch, 2011b). It is unrealistic to believe that physical education alone can close the gap between academic achievement and health problems, however physical activity provides the basis for increased cognitive function and decreased risk for health disparities. Schools have the power to educate and influence students' choices both inside and outside the classroom. However, public schools are lacking in funding and proper planning to positively influence the achievement gap.

A proper plan should be focused on risky health behaviors and modifications for those actions, specifically through obesity prevention and education (Basch, 2011a). To be able to make a connection between health disparities and academic achievement the health problem must be able to be applied to a larger population not just minority students in high school. Research has specifically examined urban minority youth, correlations between health disparities and depressed academic achievement needs a larger sample size to increase power in research. Health factors can influence cognition, sensory perceptions, engagement within the classroom and dropout rate/absence (Basch, 2011a; Basch, 2011b). Programs that support and implement eating a proper breakfast and providing physical activity throughout the day may have a greater effect on cognition, than if that child was just sitting in a classroom the entire day (Basch, 2011a). Collectively there is a positive correlation between physical activity and increased academic achievement through the areas of cognition, mental stability, and presences at school.

Outside of the classroom, researchers have examined commercial facilities in regards to increased or decreased physical activity. The structures, in which people reside, such as their home, school, or work, may affect their fitness level. If an individual does not have access to a gym or physical fitness center they will be less likely to adhere to the recommended daily physical activity guidelines (Basch, 2011a; Dowda et al., 2009). Through a geographical and social frame work, perceived relation to a fitness facilities access and peers to attend with, were the two greatest factors that attributed to teenage females inactivity levels (Dowda et al., 2009). Females that had a greater social support and were within 2.0 miles of access were more likely to participate in vigorous physical activity (Dowda et al., 2009). The third greatest direct factor is sport team membership (Basch, 2011a; Dowda et al., 2009). As females transition from adolescents to early adult they are less likely to participate in organized sports and in vigorous physical activity in general (Basch, 2011a). It is critical that healthy habits are established at a young age. Communities need to bridge the gap between access to community recreational facilities and encouragement to attend such places.

Potential Causal-Pathways

Physical activity positively impacts psychological and emotional health of youths (Basch, 2011a). Casual pathways suggest that because exercise increases metabolism activity and proficiency, major organ systems are able to function more effectively. Thus promoting increased emotional stability and ability to learn through improved physical fitness (Basch, 2011a; Strong et al., 2006). Physical activity may have a positive effect on self-concept that changes continually from puberty to adulthood (Strong et al., 2006). Individuals who do not participate in regular physical activity but are not obese, have shown negative self-esteem and emotional instability (Basch, 2011a; Florin, Shults, & Stettler, 2011) Different modalities of physical activity, such as resistance exercise or endurance exercise may have different effects on mental health (Strong et al., 2006). Participation physical activity influences engagement inside of the classroom and can in turn lead to a greater awareness of self-concept through increased academic self-confidence (Kantomaa et al., 2013). Puberty increases the risk for developing anxiety, depression and a negative self-perception (Florin et al., 2011). These conditions can negatively impact the child's ability to be alert during school and "want" to be there. Indirectly, increased physical activity has been shown to decrease these negative effects and actually promote well-being (Basch, 2011a). There is a high comorbidity of stress alongside depression and anxiety (Basch, 2011a; Holmes et al., 2009). This may be attributed to increased sympathetic nervous system stimulation. Physical activity may create an adaptive mechanism to cope with various stressors more efficiently and effectively (Holmes et al., 2009). Future research should examine exercise and coping abilities within obese or overweight children. Children who perceive themselves as overweight or obese perform negatively in school despite a medically defined obese status; and that self-perception may be a more powerful determining factor than actual obesity status (Florin et al., 2011). It is believe that self-perception can also impact emotional well-being and behavior problems (Basch, 2011a; Florin et al., 2011). If the child sees themselves in a negative light, such as obese, then they may be more likely to score lower on standardized tests and isolate themselves from their peers, decreasing their social interaction. Within the causal pathway of mental and social stability, lack of exercise increases the likelihood of negative academic performance due to poor self-perception.

Self-Prospection

An individual's feeling of connectedness to physical activity and engagement, like joining a sports team, may make them more likely to excel physically. Working with peers allows the child to focus on a task by implementing their strengths not on focusing on their weaknesses possibly making them more engaged during school (Basch, 2011a). Youths that participated in activities outside the classroom, like interscholastic sports, and who were also actively engaged within the classroom had lower dropout rates than less involved peers (Yin & Moore, 2004). Outside of the traditional classroom, civic engagement may serve as an intervention to make positive lifestyle changes including but not limited to increased exercise promotion and dietary education. Engagement in community activities such as to seed a garden or to participate in sideway sanitation, may provide a significant change in weight status for overweight children who participated within such community activities (Whetstone, Kolasa, & Collier, 2012). Although connectedness does not directly pertain to physical activity, the more the program focuses on developing the child both mentally and physically, there is a greater assumption that the child will excel inside the classroom.

Physical Activity and Cognition

Physical inactivity may have detrimental effects on cognition and brain function. Greater caloric intake and excess body fat are adversely linked to cognitive performance in youth (Kantomaa et al., 2013). Physical activity increases oxygen saturation in areas of the brain that are essential for performing tasks (Young- So, 2012; Kantomaa et al., 2013). Decreasing CVD risk, endurance exercise increases arterial compliance which increases blood flow. Increasing flow and oxygenation of blood improves the efficiency of the cardiovascular and neural systems. Cognition is affected by exercise through the increased number of neurotransmitters, increased oxygen uptake and efficiency, and boost in brain-derived neurotrophins that support cellular differentiation (Ploughman, 2008; Young-So, 2012). Increasing cellular differentiation within the brain is critical to the growth and creation of neuron survival in an adolescents growing brain. Exercise also sustains cognition by increasing neurotransmitter activity like that of serotonin and norepinephrine, physical activity may facilitate greater processing (Young- So, 2012; Kantomaa et al., 2013). Overall fitness gains in areas of strength, balance, flexibility, or speed, are associated with increases in psychological gains in the classroom. Fitness impacts student's ability to maintain alertness and process critical thinking skills (Basch, 2011a; Kantomaa et al., 2013).

Academic achievement is represented in standardized test scores, grade point averages, or other tests of cognitive functioning. High marks in fitness testing of the PACER, curl up, push up, trunk lift, flexibility tests; may lead to greater achievement in English Language & Arts, (ELA), and math scores (Joshi, Howat, & Bryan, 2011). Out of all of the fitness scores, the PACER had the highest correlation with math scores suggesting, that aerobic activity is more critical to academic performance (Joshi et al., 2011). Strength exercises, like power lifting, focus more on the musculoskeletal system and the stimulation of those muscles. Although any physical activity is better than none, resistance training may have little effect on increasing blood flow to the brain for increased brain function (Young-So, 2012). Resistance training increases balance and coordination making it critical for functional living, however there is greater evidence to suggest that endurance training. Overall being more physically fit has greater benefits that not. Evidence suggests that students who are more physically fit have higher reading scores than math, but those scores are still higher than a student's who is less physically fit (Colquitt et al., 2011; ,Basch, 2011a; Joshi et al., 2011). Flexibility is more highly correlated with language arts and math scores, suggesting that with increased balance and perception of the body, the child is able to approach course work problems and tests with greater cognitive understanding (Colquitt et al., 2011). Evidence favors a positive correlation between increased physical activity and cognition within the classroom (Colquitt et al., 2011; ,Basch, 2011a; Joshi et al., 2011). Research suggests that physical activity may increase academic perform through increased concentration and memory (Strong et al., 2006).Other areas of research should look at correlations between physical activity directly before exams or assignments within the classroom; physical activity may improve scores. Some researchers suggest that physical activity may increase academic performance, while other researchers found increased physical activity in physical education courses did not improve academic achievement (Coe, Pivarnik, Womack, Reeves, & Malina, 2006). Although, decreased time spent in the classroom to create more time for physical activity, did not decrease nor improve academic achievement (Coe et al., 2006). Coe et al., found that students who completed more vigorous activity outside of the classroom in sports did improve on academic achievement as opposed to student that increased moderate physical activity (Coe et al., 2006). The interpretation of results expresses that a threshold of intensity may need be present to increase academic performance (Coe et al., 2006).

Childhood obesity poses a large threat to the nation's stability of health. As children grow up, they are also growing out. Medical conditions like CVD and MeTs diagnoses are expected to increase in the upcoming years costing the health care industry billions of dollars. Research that is directed at developing the direct cause of obesity may be somewhat irrelevant. Obesity encompasses numerous mental and health conditions that need to be targeted individually and specifically to that person, to be diagnosed. Regardless of root of the issue, prevention through physical activity and education seem to decrease such conditions. Exercise decreases the percent body fat, BMI, blood pressure, systemic lipids, and can help improve glycemic control; all of which are risk factors for MeTs and CVD. Psychologically, obesity can causes increases in poor self-perception and negatively affect academic achievement through a lack of involvement. Again, through education and exercise these emotional conditions can be reduced if not eliminated. Furthermore, a positive relationship has been shown to exist between physical activity and academic accomplishment. Future studies should examine racial and sex differences between obesity, mental and physical well-being. Most of the research presented within this review was limited in scope of minorities and socioeconomic status of subjects. Two of the most vital components of combating obesity include informing the youth on health education and increasing activity in all aspects of their growing lives.

Childhood obesity can lead to an increased risk for the development health disparities such as MeTs and CVD, in late adolescents and adulthood. A known cause of childhood obesity has not been determined; proposing that a network of interrelated variables ranging from total energy intake and expenditure to the individual's genetic code, may be dependent on each other. Health and social constructs are affected by obesity and have the potential to be altered through proper diet and physical activity. Physical activity can decreases adiposity through weight loss which can dramatically decrease the likely hood of developing CVD and increase cognitive function by increasing oxygen flow to the brain.

CHAPTER III

METHODOLOGY

Participants

Participants were recruited from a convenient sample from a larger study through Mississippi State University Department of Education in conjunction with Mississippi public schools. Participants were mainly identified through an increased risk for not successfully completing high school. Criterion for increased risk for dropping out encompasses lack of family support, behavioral issues, frequent absences, or low test scores. The students are enrolled in the Mississippi Public school district and are in 6^{th} through 9^{th} grade. In conjunction with an increased risk for drop out, these students also come from low socioeconomic status and tend to be of minority. The subjects are enrolled in an alternative schooling program entitled Studio School which students learn by design. In Studio School learners propose solutions to questions and then critique those propositions through judgment from self and others. In design, the proposal to the question may be changed for more effective designs and learning possibilities. The core of Studio Based Learning is a universal propose-critique-iterate stance. An informational letter was sent home to be signed by the child's legal guardian for consent. The participant also signed a form for assent and was allowed to withdraw from the study at any time. Fifteen At-risk adolescents, four females and eleven males, participated within Studio school summer camp.

Controlling for maturation

Due to the age of the participants in relation to exponential growth and puberty, maturation was controlled for by the age away from peak height velocity curve. From birth to the age of two, children undergo growth within a rapid amount of time. Growth is then slowed until puberty in which there is another spike in growth of about ten centimeters per year around the biological age of twelve and fourteen for females and males, respectfully. The participants in this study were measured during the suggested age of puberty. Thus, to correctly measure participants age a prediction equation was used to determine potential peak height a non-invasive technique.

Metabolic syndrome score

There is no set metabolic syndrome criterion due to a low prevalence score in children; because MeTs is influenced by maturity status a composite score was regressed onto age. Due to the small sample size sex and ethnicity could not be standardized and thus multiple composite scores were created. A composite score was found by a generating a sum of the age-standardized residuals (Z-scores) for glucose, HDL, mean atrial pressure, waist circumference, and triglycerides and regressed on to maturity status. Typically, metabolic syndrome does not appear until adulthood thus a Z-score allows the individual to have a continuous value that is comparable to others participants based on age- and sex- specific variables. A high score is suggestive of increased metabolic risk factors compared to other participants in the study.

Procedures

Data collection took place during two weeks of Studio School Day Camp from 8:30 am to 11:30 am, Monday through Thursday. Upon arrival participants were given GTX_{3+} accelerometer (Actigraph, Pensacola, FL) that was worn on the subjects' right waist at the mid-auxiliary line for the duration of the camp. Participants received instruction constructed upon Studio based learning activities then allowed free time for play. Activities ranged from basketball, racquetball to walking around a track. During the fall semester of 2013-2014 school year participants were again given a GTX_{3+} accelerometer to be worn for the duration of the school day for the week, five days in total. The accelerometer was handed out to participants before school at 8:00 am, and then collected at the end of each day at 3:00 pm. Students were instructed to wear accelerometer on right hip for the entire school day. Physical activity was measured in minutes spent in sedentary, light, moderate, and vigorous physical activity set to 10 second epoch. Raw acceleromety was analyzed with Actilife 6 software using Evenson (2008) cut points, in accordance with recent data processing recommendations (Trost S, Pfeiffer K, et al., 2011).

Anthropometric measurements

Anthropometric measurements were taken in the summer at Studio School Camp and then again within the fall semester assessed in duplicate by single technician. Sitting and standing height were taken on a portable stadiometer and according to standard procedures. The participant was instructed to take off their shoes and stand erect with back against the stadiometer. With heels placed firmly on the ground, shoulder width apart, and head within the Frankfort plane, the student was instructed to inhale deeply. At the highest point inhalation, standing height was measured in centimeters. The action was repeated for reliability, and then trails were averaged. Next, the participant sat on a standard stool that was placed against the stadiometer. The subject was asked to sit on the stool with head in the Frankfort plane, shoulders back and feet dangling. Instructed to inhale deeply, sitting height was measured at the highest point of inhalation by the participants. Seated height was measured twice then average sitting height was found. Weight was determined in kilograms from a digital scale that also calculated percent body fat through foot to foot bioelectrical impedance analyzer (Tanita Corporation, Japan). Subjects were instructed to remove socks and shoes so that skin was in direct contact with scale. Body mass index was calculated through weight in kilograms and standing height in meters. Waist circumference was taken about the iliac crest with a standard Gulick tape measure. The subject was asked to lift up clothing so that skin was exposed to prevent measurement error from excess clothing layers. The tape was pulled taught around the participant's waist and read in centimeters in relation to the point at which the tape crossed. Waist circumference was measured twice then averaged.

Blood pressure

The participants were instructed to sit quietly for at least ten minutes to ensure resting values of blood pressure. An automated blood pressure machine was used to collect pulse and blood pressure, recorded in systolic and diastolic blood pressures, mmHg respectfully (Dinamap). Cuff size was determined and selected based upon participants upper arm circumference. Blood pressure and pulse rate were generated twice, with the average of the values used for data. Mean atrial pressure (MAP) was calculated for metabolic syndrome composite score by the equation [(SBP-DBP/3) + DPB].

Fasting blood sample

Biochemical measures were only taken once in summer camp. Participants were asked to not consume any food or drink before camp one morning in order to acquire a fasting sample of blood glucose and lipid profile. A consent form for a fasting sample was sent home with students to be signed by the participant's legal guardian. To participate within the sample participant had to complete an assent form. A total of eleven students participated in the blood sample. In order to promote participation students were provided breakfast as well as a gift card for frozen yogurt at the completion of procedure.

A blood sample was provided from a finger stick on the distal phalange of the participants non-dominate hand. Subjects washed hands in warm water to increase blood flow to phalanges and decrease spread of bacteria. Next, a rubbing alcohol wipe was used to clean the surface. A lancet was used to minimize discomfort of the participant. A blood sample of 35 μL of was captured and collected through a capillary tube. To decrease bleeding the subject was instructed to apply moderate pressure to the finger stick site. The subject was then allowed to select a Band-Aid and eat breakfast. During that time, the capillary tube was mounted onto a desktop analyzer that computed blood glucose, triglycerides, and lipoprotein cholesterol within the sample (Cholestech LDX System). Results were recorded for the data set as well as sent home with the participant. A "Health Report Card" was created to reflect adolescent growth and health development through standard ranges. The report card was then sent home to provide the legal guardian with general health results like fasting glucose and weight, of the participant.

Measurement of academic achievement

Academic achievement was measured by cognitive achievement through results from standardized Mississippi curriculum testing. Exams were administered by school staff in the spring and fall semesters. The district provided test results for each participant within the study. The student was tested in areas of literacy and language, numeracy and mathematics. MAP or, Measures of Academic Progress, was used to determine academic achievement reported as an RIT score (Rasch Unit) that is an estimation of a student's instructional level and measurement of progress in school. The MAP test is given to students within the fall and spring semester and provides the educator with a snap shot of the students understanding at that time. Educators then use results to develop targeted instructional strategies for individual classroom improvement. Evaluation scale extends from 100-300 and is based upon the district and grade level RIT score. Pre-treatment academic measurements were compared to scores taken during the fall semester of 2013-2014, post-treatment respectfully. Pre-treatment MAP scores for grades 6th through 8th were used from the spring semester of testing in 2012-2013. Post-treatment included MAP scores for students in middle school, grades 6th through 8th. For participants that transitioned into 9th grade For students that were in 9th grade during the school year of 2012-2013 the Mississippi benchmark test, Subject Area Testing Program 2 (SATP2) was completed in literacy and, algebra, and biology. Raw scores were coded 1.0-4.0, minimal to advance based upon RIT scores.

Data Analysis

Participant characteristics were created from descriptive statistics. Mean and standard deviation were generated for all descriptive. Metabolic syndrome composite score (MeTs) was assessed via biochemical markers (glucose, triglycerides, high-density lipoprotein) and anthropometric measures (waist circumference and mean arterial pressure). All variables were examined individually and then as a combined risk score. Metabolic health was also assessed via body mass index and waist circumference. Separately the two academic subject areas, math and language, were partially correlated to the calculated MeTs composite score to assess the relationship between academic achievement and metabolic health. Maturity status and gender were controlled for. Physical activity was examined through hour by hour analysis of minutes spent in sedentary, light, moderate, and vigorous physical activity. Paired t-tests were then used to compare the amount of moderate to vigorous physical activity (MVPA) achieved at camp to MVPA achieved during a traditional week at school.

CHAPTER IV

RESULTS

Table 1 provides descriptive statistics for the current study sample during the Studio Summer Camp (2013). Among the total sample, (n=15) mean height was within the 50th percentile and mean weight was less than the 75th percentile when plotted on the growth chart (Ogden et al., 2002). BMI in the total sample was greater than the 85th percentile when plotted on the growth chart. According to growth chart percentiles for BMI, participants were considered collectively overweight. In the total sample both systolic and diastolic blood pressures were within the 50th percentile when charted on gender by age and height percentiles (National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents National High Blood Pressure, 2004). The biochemical marker of fasting glucose in the total sample was 83.3 (+8.5) mg/dL, not considered a high risk at $\leq$110 mg/dL. Total cholesterol, low-density lipoprotein, and triglycerides were within normal ranges (Hickman et al., 1998) at 143.6 (+18.0) mg/dL, 82.7 (+23.5) mg/dL, and 75.3 (+43.8) mg/dL, respectfully. High density lipoprotein was greater than 35 mg/dL at 42.3 mg/dL within the total sample. Age away from peak height velocity was used as an indicator of maturity status and categorized participants as late matures. Table 2 shows participants characteristics during the fall. Within the total sample BMI was greater than the 85th percentile when plotted on the growth chart. Mean height for the sample was in the 50th percentile and mean weight was within the 75th percentile when plotted on the growth chart.

Measures of academic achievement, both mathematic and language test scores are represented in Table 3. Pre-measurements were taken during the previous school year before intervention. Post measurements served as indicators for academic achievement. Raw scores show trends of improvement, however when categorized for skill level, a majority of raw scores are still below the minimal and basic proficiency level for current grade level (data not shown).

Table 4 and Figure 1, show partial correlations between math test scores, and metabolic health. Once adjusted for gender and maturity status, metabolic syndrome composite score was not associated with math test scores ($r < -0.56$, $p=0.20$) and was not in the expected direction (i.e. positive). Several metabolic health variables (TG, GLU, WC, and BMI) were not significantly related to math achievement and were unexpectedly in the inverse direction (Figure 1). Table 6 and Figure 2 depict partial correlations between language pre-test scores and metabolic health variables. After adjustment for gender and maturity status, a low correlation ($r < 0.20$, $p=0.66$) was found between language academic test scores and metabolic syndrome composite score. Although not statistically significant, it was in the expected positive direction (Figure 2).

Paired t-test was used to determine mean differences between physical activity attained during the summer camp and physical activity attained during one week in the fall school year. Mean differences suggest that on average during camp participants spent 34.8 minutes in moderate-vigorous physical activity (MVPA) compared to 6.7 minutes in MVPA during the school year. Paired samples correlation showed significance for

MVPA on first day of camp compared to MVPA during one traditional school day ($r <$ 0.69, $t = 22.1$, $p < 0.05$). A trend towards significance was found for the remaining activity days. These results suggest that participants received more MVPA during a SBL environment compared to a traditional school environment.

Table 1

Participant Characteristics from Summer Camp: anthropometric and metabolic variables

Anthropometric Variables	**Total Sample (n=15)**	**Male (n=11)**	**Female (n=4)**
Age (yrs)	13.9 (±1.3)	14.1 (±1.2)	13.3 (±1.6)
Height (cm)	163.7 (± 10.9)	166.1 (±11.8)	157.0 (±2.8)
Weight (kg)	62.6 (±11.9)	64.1 (±13.2)	58.3 (±7.0)
Waist Circumference (cm)	77.2 (±11.6)	76.9 (±12.1)	78.0 (±11.9)
% Body Fat	23.0 (±10.4)	19.8 (±10.0)	31.6 (±5.8)
BMI (kg/m^2)	23.4 (±4.6)	23.3 (±5.1)	23.7 (±3.3)
APHV (yrs)	15.3 (±.6)	15.3 (±.6)	15.4 (±.8)
Metabolic Variables			
MAP (mmHg)	78.5 (±4.5)	78.2 (±4.7)	79.5 (±4.3)
SBP (mmHg)	112.5 (±6.9)	112.6 (±8.3)	112.1 (±3.0)
DBP (mmHg)	61.9 (±4.1)	61.4 (±3.7)	63.1 (±5.3)
Glucose (mg/dL)	83.3 (±8.5)	82.1 (±9.1)	86.3 (±7.0)
LDL (mg/dL)	82.7 (±23.5)	86.2 (±27.2)	74.0 (±11.3)
HDL (mg/dL)	42.3 (±8.0)	40.5 (±8.3)	47.0 (±5.6)
Total cholesterol (mg/dL)	143.6 (±18.0)	143.5 (±20.7)	144.0 (±11.5)
Triglycerides	75.3 (±43.8)	71.3 (±42.6)	86.0 (±54.6)
MeTs Score	-0.04 (±3.4)	-0.3 (±3.6)	.74 (±1.8)

BMI, body mass index; APHV, age at peak height velocity; MAP, mean arterial pressure; SBP, systolic blood pressure; DBP, diastolic blood pressure; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol; MeTs, Metabolic Syndrome

Table 2

Participant Characteristics from Fall: anthropometric

Anthropometric Variables	Total Sample (n=15)	Males (n=11)	Females (n=4)
Age (yrs)	14.3 (±1.4)	14.7 (±1.3)	13.6 (±1.6)
Height (cm)	164.9 (± 10.8)	167.5 (±11.3)	157.9 (±5.4)
Weight (kg)	63.4 (±12.1)	65.0 (±13.2)	59.3 (±8.6)
Waist Circumference (cm)	77.5 (±11.2)	76.7 (±11.2)	79.7 (±12.5)
% Body Fat	23.2 (±10.5)	20.1 (±10.1)	31.7 (±6.5)
BMI (kg/m^2)	23.4 (±4.6)	23.2 (±4.8)	23.9 (±4.3)
APHV (yrs)	15.5 (±0.6)	15.5 (± 0.6)	15.5 (±0.9)

BMI, body mass index; APHV, age at peak height velocity

Table 3

Participant Characteristics: Measures of Academic Achievement.

Academic Achievement	Total Sample (n=15)	Males (n=11)	Females (n=4)
Pre Test Math Score	209.8 (±10.8)	209.6 (±8.7)	210.3 (±16.3)
Post Test Middle School Math Score	206.9 (±11.4)	201.8 (±4.9)	213.7 (±14.6)
Post Test High School Math Score	651.3 (±13.3)	653.0 (±18.4)	648.0 (±0)
Pre Test Language Score	209.8 (±10.8)	209.6 (±8.7)	210.3 (±16.3)
Post Test Middle School Language Score	197.7 (±18.4)	188.3 (±18.2)	210.3 (±10.0)
Post Test High School Language Score	644.0 (±1.4)	645.0 (±0.0)	643.0 (±0.0)

Table 4

Associations between metabolic health and pre mathematic academic achievement

	Math Test Score	MeTs Score	HDL-C	GLU	TG	MAP	WC
Math Test Score	*						
MeTs score	-0.56	*					
HDL-C	0.63	-0.61	*				
Glucose	-0.39	0.77	-0.03	*			
TG	-0.54	0.93	-0.76	0.61	*		
MAP	0.21	0.37	0.25	0.43	0.06	*	
WC	-0.63	0.98	-0.67	0.74	0.93	0.21	*
BMI	-0.57	0.97	-0.46	0.85	0.83	0.47	0.95

MeTs, Metabolic Syndrome; HDL-C, high density lipoprotein cholesterol; GLU glucose; TG, triglycerides; MAP, mean arterial blood pressure; WC, waist circumference; BMI, body mass index

Table 5

Association between metabolic health and post mathematic academic achievement

	Post Math Test Score	BMI
Post Math Test Score	*	
BMI	0.001	*
WC	0.06	0.99

WC, waist circumference; BMI, body mass index

Table 6

Association between metabolic health and pre language academic achievement

	BMI	WC	MAP	GLU	HDL	TG	MeTs Score
BMI	*						
WC	0.95	*					
MAP	0.47	0.21	*				
GLU	0.85	0.74	0.43	*			
HDL	-0.46	-0.67	0.25	-0.03	*		
TG	0.83	0.93	0.06	0.61	-0.76	*	
MeTs Score	0.97	.98	0.37	0.77	-0.61	0.93	*
Language Test Score	0.22	.013	0.28	0.58	0.42	0.20	0.20

MeTs, Metabolic Syndrome; HDL-C, high density lipoprotein cholesterol; GLU, glucose; TG, triglycerides; MAP, mean arterial blood pressure; WC, waist circumference; BMI, Body Mass Index

Table 7

Association between metabolic health and post language academic achievement

	Post Language Test Score	BMI
Post Language Test Score	*	
BMI	0.65	*
WC	0.68	0.99

WC, waist circumference; BMI, body mass index

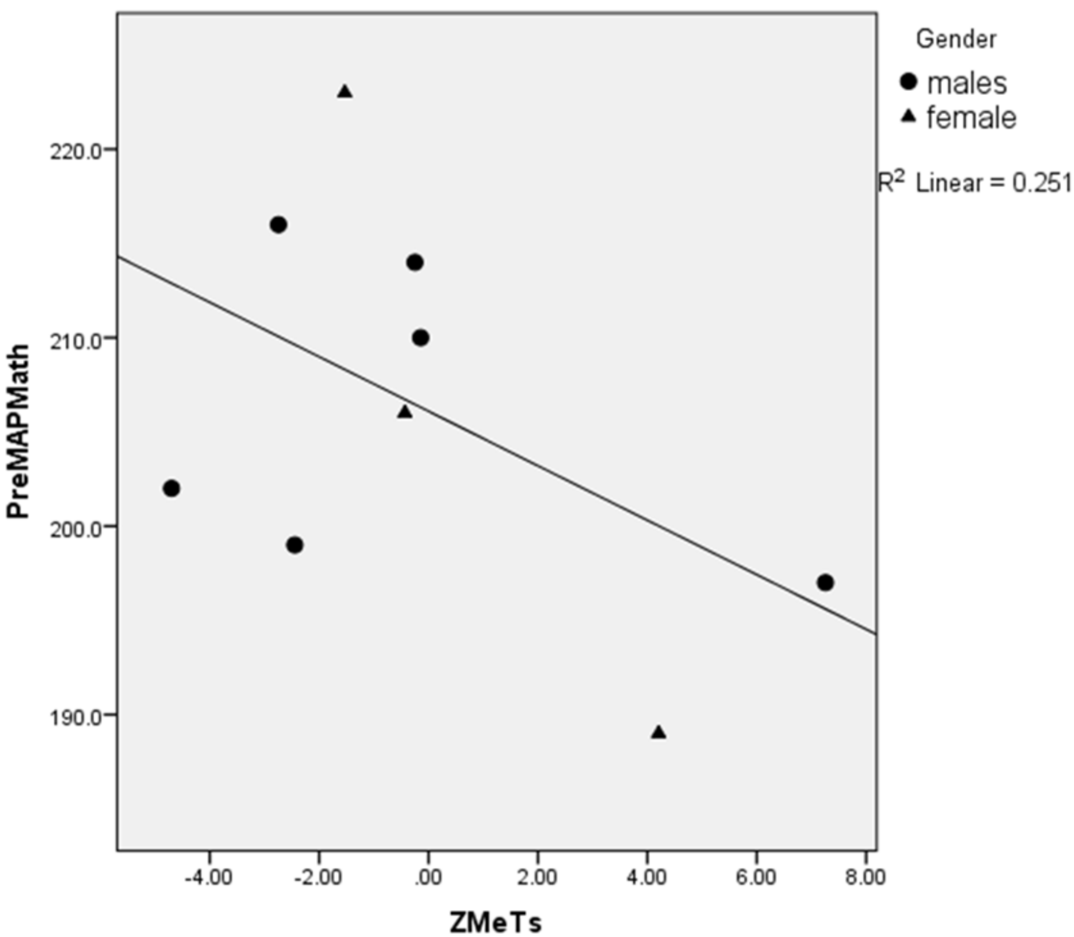

Figure 1. Association between metabolic health and math academic achievement

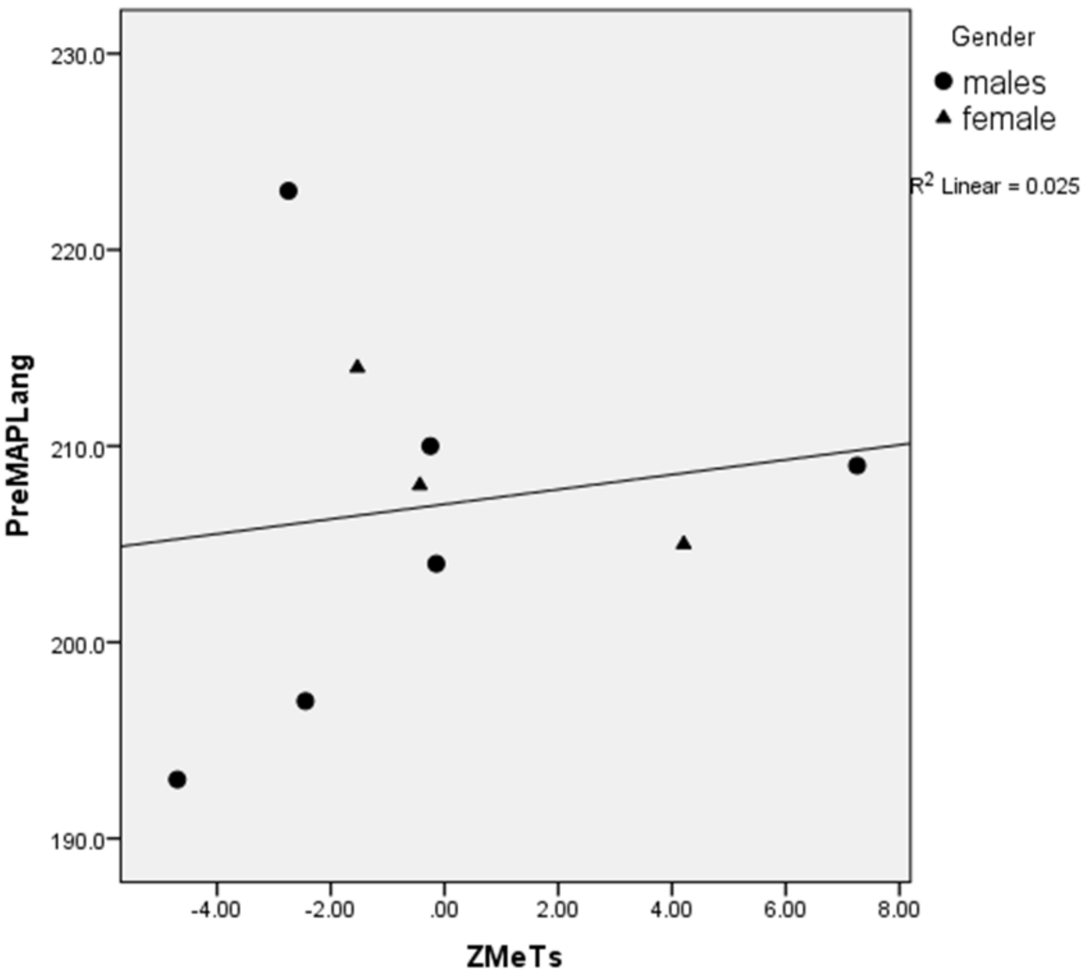

Figure 2. Association between metabolic health and language arts academic achievement

Table 8

Physical Activity levels at Studio School Summer Camp compared to Traditional School.

	MVPA (min/day)	**Moderate PA (min/day)**	**Vigorous PA (min/day)**
Camp Day 1	41.4 (±7.1)	25.8 (±4.5)	15.6 (±7.4)
Camp Day 2	41.6 (±16.3)	20.6 (±6.3)	21.0 (±13.0)
Camp Day 3	17.8 (±4.0)	16.0 (±3.1)	1.8 (±1.5)
Camp Day 4	35.4 (±13.5)	18.0 (±7.2)	17.4 (±11.2)
Camp Day 5	37.8 (±19.7)	19.0 (±7.2)	18.9 (±15.6)
School Day 1	8.6 (± 6.4)	6.5 (±4.6)	2.1 (±2.4)
School Day 2	8.7 (± 5.8)	6.4 (±4.4)	2.2 (±1.6)
School Day 3	6.4 (± 4.8)	4.7 (±3.6)	1.7 (±1.6)
School Day 4	4.9 (±5.2)	3.6 (+3.9)	1.3 (±1.5)
School Day 5	4.8 (±5.0)	3.5 (+3.5)	1.4 (±1.6)

MVPA, moderate vigorous physical activity; PA, physical activity

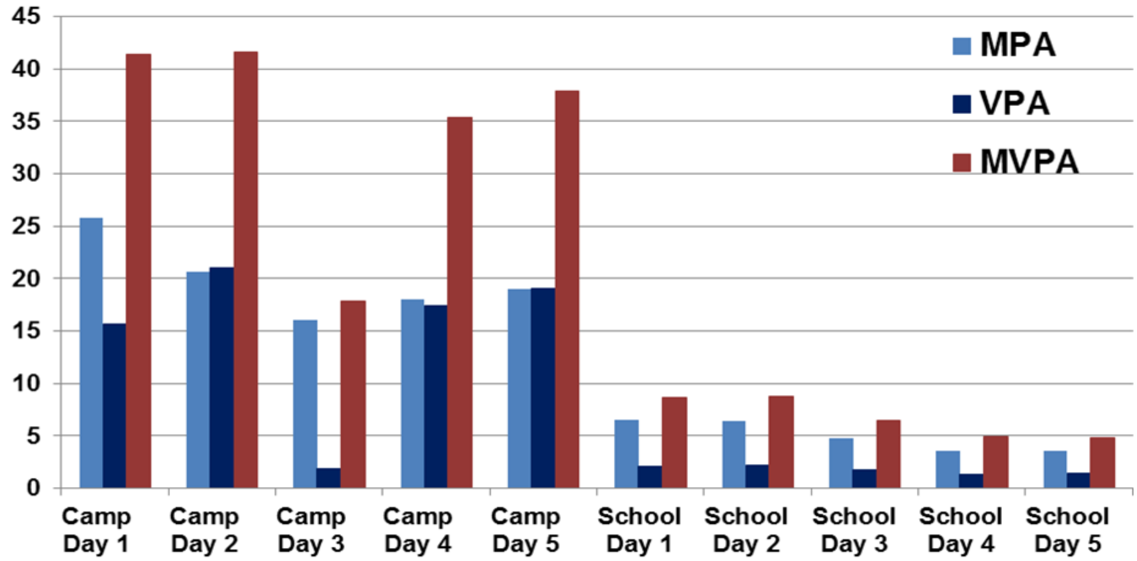

Figure 3. Physical activity at summer camp compared to traditional school

CHAPTER V

DISCUSSION

Previous research suggests there is an association between academic achievement and metabolic health; specifically, a positive correlation between metabolic health disparities and poor academics (Judge & Jahns, 2007; Yau et al., 2012). The purpose of this thesis was to describe the relationships between health disparities and academic disparities and investigate the potential role that physical activity may play on these relationships in at-risk youth. It was hypothesized that there would be a positive correlation between poor metabolic health and adverse academic achievement. Results from this study suggest that metabolic health did not influence academic achievement within this small sample. Little variability was observed among raw test scores between the pre-test administered during spring of 2013 and the post-test taken during the fall of 2013. Although test scores improved for some students, most test scores were not passing by district standards.

Metabolic Health and Academic Achievement

The present study found little association between metabolic health and academic achievement. The correlation between metabolic health and math academic achievement was low, ($r < -0.56$) and not in the expected positive direction. Likewise, there was little association between language test scores and metabolic health ($r<0.20$), however the relationship was in the expected direction. Research on the relationship is highly conflicted and inconsistent; findings from this study supports Abdelalim and colleagues in which obese participants did not score worse than other non-obese participants (Abdelalim, Ajaj, Al-Tmimy, Alyousefi, Al-Rashaidan, Hammound, & Al-Taiar, 2012). A possible explanation stems from variation between scores. Subdivided into four categories, academic achievement was based off of minimal, basic, proficient, and advanced. Most participants scored within the minimal and basic categories both for pre- and post-assessments of math and language. A small portion of subjects scored lower on the post-assessments suggesting presence of confounding psychological and psychosocial variables. Florin and associates suggests that self-proprioception impacts the child's emotional stability and behavior both in and out of the classroom. Pediatric obesity may negatively impact relationships formed with peers and teachers that may in turn decrease the ability to pay attention during school and make the completion of homework much more difficult (Florin et al., 2011). It is possible that subjects may have perceived themselves as overweight or obese and in turn negatively affected social stability found in peers. Lack of engagement in the classroom from decreased social interaction may negatively impact academic achievement (Basch, 2011a; Florin et al., 2011; Abdelalim et al., 2012). Basch found that students who connected and worked with peers focused more on accomplishing academic tasks than areas of weakness or perceived inability to complete the task alone (Basch, 2011a). A major focus of Studio Based Learning (SBL) summer camp was to promote positive relationships with peers and authority figures, like teachers or guardians. An individual's feeling of connectedness and respect may take longer to develop and may not be able to translate from SBL into the traditional classroom setting. It is possible that participants who have been identified as at-risk within this study performed negatively in measures of academic achievement due to decreased self-prospection. If the adolescent does not feel motivated to perform well or interact within the classroom, it stands to reason that retention will also be affected. Future research should expand upon psychological factors like motivation and attitude and potential effects on this at-risk population.

Participants in the present study were generally overweight with a mean BMI of greater than the 85th percentile. An elevated BMI in youth increases risk for development of disease and is also associated with decreased cognitive function and academic performance (Florin et al., 2011; Kantomaa et al., 2013).

Yau and collages found non-diabetic obese youth with metabolic syndrome scored lower across the cognitive domains (i.e. spelling and arithmetic) than those without metabolic syndrome. Unlike the present study, Yau and collages used magnetic resonance imaging (MRI) on participants and concluded that subjects that have metabolic syndrome also tended to have decreased hippocampal volumes, increased overall cerebrospinal fluid volume, and compromised white matter microstructural integrity possibly accounting for decreased attention spans and estimated lower intellectual functioning (Yau et al; 2012). Future research should explore possible implications of SBL on brain function through MRI. Because the adolescent brain is still maturating and growing, it may be found that SBL may increase cognitive function through increasing hippocampal volume or decreasing cerebrospinal fluid volume.

Results suggest there is little or no association concerning metabolic health and academic achievement. A statistically significant relationship between BMI and math test results was not observed. However, the association was in accordance with findings from research by Baxter and colleagues who also noted an inverse relationship between math and BMI (Baxter, Guinn, Tebbs & Royer; 2013). A potential explanation for the present study's finding of an inverse relationship may suggest that subjects spent more time in productive sedentary pursuits, such as studying or reading, which may help explain the greater achievement in math among those with accounting for a greater BMI.

Influence of Physical Activity

A key finding within the present study addressed physical inactivity in youth. Compared to a traditional school environment in which students spent an average of 6.7 minutes in moderate-vigorous physical activity, a studio based learning environment provided significantly more physical activity for participants of 34.8 minutes. The Federal Guidelines for Physical Activity suggest youth participate in at least 60 minutes of moderate to vigorous physical activity (MVPA) a day, with at least 3 days or 180 minutes of vigorous play (CDC, 2012). Recent reports suggest that adolescents are insufficiently active, where less than 20% of youth in public schools adhere to the play 60 standard (CDC, 2012; Strong et al., 2005). Since youth spend a majority of their day in school, about six to eight hours, the school setting is a primary target for interventions addressing inactivity.

In 2002 the United States Department of Education in conjunction with the United States National Academies committee on Science, Engineering, and Public Policy, created "Mathematics and Science Partnership" (MSP) in which guidelines were generated to reassess education across the nation. MSP places a greater focus on core STEM (science, technology, engineering, and mathematics) curriculum instead of electives, like physical education (PE), to increase America's competiveness in an international job market (United States Department of Education, 2002). The program is intended to enhance academic achievement in mathematics and science by increasing content knowledge and teaching skills of educators and is the key resource in the "No Child Left Behind Act" (USDE, 2002). It is logical to infer that the MSP classroom reform prompted the removal of physical education courses from core curriculum to concentrate on improving STEM test scores (Tompkins et al., 2012). Subsequently, activity courses still intact spend a majority of time in instruction and less time in MVPA (Donnelly & Lambourne, 2011; Tompkins et al., 2012). Strong and colleagues suggest that supervised and guided instruction by individuals who work directly with children is critical in youth acquiring skills for physical activity (Strong et al., 2005). Within the present study sample, PE had not been removed from district curriculum, however out of participants enrolled in high school only one of them was registered for one eight week semester of PE. All Students in middle school, grades 6th-8th, were enrolled in PE for the entire school year. It would be expected that the average time in MVPA would be greater than 6.7 minutes for all grades levels examined (6th-9th) during a tradition school environment due to enrollment in activity courses. It is possible that students may spend a majority of time in instruction instead of time in play. Aside from the physical education classroom, the traditional school environment promotes a sedentary lifestyle through hours of sitting during academic instruction (Donnelly & Lambourne, 2011). Implementation of SBL may be beneficial in the facilitation of adolescents attaining government standards of MVPA through the promotion of learning through physical activity. Within districts that have removed physical education, SBL may be particularly valuable as an inexpensive alternative to activity courses.

Although there has been conflicting data supporting physical activity and improvements in academic achievement, research suggests that exercise is beneficial to whole-body function (Hotting & Roder, 2013, Tompkins et al., 2012, Donnelly et al., 2013). Physical activity increases oxygen saturation in areas of the brain that are essential for performing tasks associated with learning through increased neurotransmitter activity (Young- So, 2012; Kantomaa et al., 2013). Physical activity may increase cognitive function and retention of material to aid in the promotion of academic achievement, although results from this study show little association. It is reasonable to suggest that although SBL provided significantly more physical activity, participants attend a traditional school throughout the year and may not receive physical activity benefits due to inactivity outside of camp. Immature frontal lobes like that seen in youth may be especially sensitive to experiences and in turn might be more susceptible to the benefits physical activity (Hotting & Roder, 2013). Results from Coe and associates, suggest that there could be a threshold for benefits of physical activity in vigorous level (Coe et al., 2006). Student's performance increased academically after undergoing vigorous physical activity compared to no academic improvement after moderate activity (Coe et al., 2006). Unlike Coe et al., which used direct observation or activity recall to measure MVPA, the present study monitored physical activity in three planes of motion using acceleromety. In congruence, Donnelly and colleagues used accelerometers and found similar results in activity levels. Students were more likely to be active when play was incorporated into curriculum as opposed to other approaches where involvement is optional (Donnelly et al., 2013). Although socioeconomic status was not directly measured within this study, it is an identifier for at-risk individuals. In the present study, participants tend to be of low status which may affect optional involvement in activities like recreational sports and in turn daily physical inactivity. Through the emerging classroom reform, studio based learning may encourage movement throughout the lesson actively learn through making and doing.

Conclusion

The present study found little association between academic achievement and metabolic health in this small sample. It is reasonable to suggest that due to low variance between raw scores of academic achievement may suggest presence of confounding psychological and/or psychosocial variables. A key finding suggests that adolescents participated in more MVPA during SBL summer camp compared to a traditional school environment. SBL creates an effective learning environment that is also conducive to promoting physical activity during the school day by providing goal-oriented, structured activity. Implementation may be particularly beneficial for students identified as needing alternative physical education and core curricular programming. When coupled with the small sample size of the present investigation, the small variability observed among test scores suggests that few statistically significant associations would be observed. Nonetheless, this study is a critical exploratory step, and functional examination of the widening achievement gap between at-risk youth.

Limitations

The results of this study specifically the measures of academic achievement were inconsistent between participants. Due to the districts' ordered test dates some students took exams in the fall semester while others will take the same exam in the spring semester. The SATP2 was only given to high school students whereas the MAP was given to all participants and used as pre-treatment. Multiple subjects had incomplete academic records. This may be explained by participants' absence from exams, recently transferring into the district, or results that had not been uploaded to district academic tracker. Raw scores lacked in variation between pre- and post- measures. Most students did not pass district exams and although raw scores increased, most measures were still not passing grades. Due to the small sample it is possible that there may be an association between metabolic health and academic achievement in a much larger sample. Participants were recruited from a cohort of identified adolescents as at-risk of drop out. Overall, the goal of Studio School is to prevent students from dropping out of high school before completion and over the course of the study one participant did drop out of school.

Although the present study is a cross-sectional analysis, it served as an addition to a service based project. A possible limitation in research design data collection suggests that there are multiple years of data collection on only a few participants. Specifically, participants in lower grade levels have multiple years of pre-assessments but only one year of post-assessment. Likewise, older participants have either completed high school or have graduated from pre- and post-assessments. Future research design in data collection should target a specific grade level.

Strengths

A major strength of this study is the use of a MeTs score so that participants were assessed through individual and combined risk factors rather than examining BMI only. Due to lack of specific cut points for MeTs in adolescents and delayed disease manifestation, prevalence is relativity low in youth. A composite score allows each participant to obtain a healthy or diseased status relative to the study sample. Academic achievement measures, MAP and SATP2, were given by school district and assessed objectively based upon standardized test, independent of principle investigators. Anthropometric and biochemical measures were taken in duplicate by trained researchers instead of self-reported by participants or participant's legal guardian.

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