DIET AND MEDIA COMPONENTS RELATED TO CENTRAL ADIPOSITY IN PREPUBERTAL CHILDREN

BY

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DISSERTATION

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ABSTRACT

Overweight and obesity in childhood have tripled since 1980 and currently stand at 30% and 17% among 2-19-year-olds (Ogden et al., 2010), respectively. Excess fat mass in childhood is a strong predictor of obesity in adulthood and can lead to life-threatening medical conditions, such as diabetes, coronary heart disease, and certain cancers (Flegal et al., 2010). Previous studies have utilized BMI as the primary outcome and failed to measure diet and activity-related effects on actual fat mass. Abdominal adipose tissue (central adiposity) in children has been previously correlated with higher plasma lipids, elevated blood pressure, and insulin resistance (Daniels et al., 1999; Morrison et al., 1999; Krekoukia, 2007). Furthermore, children above the recommended values for waist circumference-for-age ($\geq 75^{th}$ percentile) and waist-to-height ratio (≥ 0.5) have elevated lipid profiles and higher insulin resistance (Savva, 2000). These studies suggest that central adiposity may be the most clinically relevant distribution of body fat in children, as is the case with adults. The overall objective of this research was to determine how media use and diet intake, independently or in concert, affect central adiposity in prepubertal children. Our central hypothesis was that poor diet quality is related to increased central adiposity, independent of aerobic fitness. The aims of our study were to determine the relationships between: 1) media use and central adiposity; and 2) diet and central adiposity.

Prepubertal children (113 females and 116 males) were recruited from an on-going NIH-funded afterschool physical activity research trial (FITKids). Pubertal staging was assessed using a modified Tanner Staging System (Tanner, 1962; Taylor, 2001). Parents reported their child's weekday and weekend television (TV) and videogame use. Maximal oxygen consumption (VO_{2max}) and one 24-hour recall were used to assess fitness level and dietary intake, respectively. Dual energy X-ray absorptiometry (DXA) was used to measure whole body percent fat mass

(WB %FM) and central adiposity (FM-abd). Gender-specific waist circumference-for-age

percentiles (WC-age) and waist-to-height ratio (WHtR) were determined to further assess central

adiposity.

Body composition results showed that females (N=105) had significantly higher WB

%FM (p<0.001) and FM-abd (p<0.001) compared to males (N=109). Among females, pubertal

staging was positively related to WB %FM (r=.37, p<0.001) and FM-abd (r=.48, p<0.001).

Pubertal staging was not related to adiposity measures among males (p>0.05). However, fitness

was inversely related to FM-abd among females (r=-.59, p<0.001) and males (r=-.47, p<0.001).

Weekend TV time among females was related to increased FM-abd (r=.17, p=0.03) and

WHtR (r=.22, p<0.001), after controlling for fitness. Females who watched more than 2 hours of

TV/day had significantly higher FM-abd (p=0.03). Females above the recommended WC-age

cutoff (≥75th percentile) had significantly higher cholesterol-saturated fatty index (CSI) (p=0.04)

and intake of added sugars (p<0.001). CSI was the only dietary variable related to increased

FM-abd among females, after controlling for both fitness and energy intake (r=.26, p=0.03).

However, no diet-body composition relationships remained significant after controlling for

fitness and energy intake among males.

Standard linear regression models suggested that the strongest predictors of FM-abd

among females were pubertal staging (β=.418, p<0.001) and fitness (β=-.405, p<0.001). The

addition of energy intake, added sugars, and CSI accounted for an additional 10% of the variance

in FM-abd. The same model explained 53% of the variance in WHtR. Among males, age was a

positive predictor (β=.306, p=0.005) and fitness was a negative predictor (β=-.453, p<0.001) of

FM-abd. Subsequent addition of diet variables only accounted for 0.5% of the variability in FM-

abd. Fitness was the strongest predictor of WHtR (β=.331, p=0.005). Among females, pubertal

staging accounted for 13% of the variability in WB %FM. Energy from protein was a positive predictor of whole body adiposity (β=.265, p=.007). However, the contribution of energy from protein became non-significant when energy from fat was included in the model. The overall model accounted for 52% of the variability in WB %FM. Among males, age (β=.335, p=.001) and fitness (β=-.427, p<0.001) remained the strongest predictors of WB %FM.

In conclusion, females and males differed across all measures of adiposity, including the primary outcome of FM-abd. Weekend TV time appeared to influence energy intake, cholesterol and added sugars, however, these relationships attenuated once energy intake was controlled for. Added sugars and cholesterol-saturated fatty acid index were important predictors of central adiposity. After controlling for fitness and energy intake, the influence of these nutrients was non-significant among males. Collectively, these results suggest that dietary and sedentary behaviors may have differential health-related outcomes for prepubertal children based on gender. Body composition appeared to be significantly influenced by pubertal staging in girls and chronological age in boys. Therefore, our findings have implications for nutrition intervention efforts targeting obesity prevention during the critical period of preadolescence. Future work is needed to assess influence of diet and media on central adiposity as children transition into adolescence.

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LITERATURE REVIEW

Definition and Prevalence of Obesity

Overweight and obesity are defined as excessive fat accumulation that may impair health (Caterson, 2002). Although there are several accurate methods of measuring fat mass/adiposity including magnetic resonance imaging (MRI) hydrostatic weighing, dual energy X-ray absorptiometry (DXA), the cost and need for trained personnel limits the widespread use of these techniques in both clinical and public settings. Furthermore, there are no well-accepted ranges for adiposity in children or adults (Flegal, 2006). Therefore, weight adjusted for height [expressed as body mass index (BMI), calculated as weight in kg divided by square of height in meters] is often used as a surrogate measure of adiposity. This index was first devised by the Belgian statistician Adolphe Quetelet (1797-1874), who applied it to adults. Subsequently, it was shown that if fat mass was independent of height, then BMI correlated highly with adiposity (Benn, 1970; Keys et al., 1972; Romero Corral, 2008). Among adults, the BMI cutoffs for overweight (BMI ≥25) and obese (BMI ≥30) are based on fixed values that are related to health-risk (Janssen, 2002). According to these definitions, worldwide obesity has more than doubled since 1980 with approximately 1.5 billion adults estimated to be overweight. This upward trend has been especially rapid in developed countries including the United States where 68% of the adult population is overweight and 32% are obese (Flegal et al., 2010).

Among children, BMI varies considerably with age. Therefore, a child's BMI is compared with that of a reference population of the same gender and age to assess adequate growth throughout childhood (Ebbeling, 2008). Both the World Health Organization (WHO) and the Centers for Disease Control (CDC) (2000) growth charts provide reference populations

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for determining BMI-for-age percentiles. In the United States, the CDC (2000) charts are primarily used for growth assessment of children over 2 years. According to the CDC charts, obesity in childhood has tripled since 1980 and current estimates of overweight (≥85th percentile) and obese (≥95th percentile) prevalence among children stand at approximately 32% and 17%, respectively. Prevalence differs across race and ethnicity; 39% of Hispanic and African-American children (6-11 years) have a BMI at or above the 85th percentile compared to 28% in Caucasian (Ogden et al., 2010). Although prevalence of obesity among all 2-19-year-olds has remained stable in recent years, trend analysis among boys shows significant increases since 2000. Of further concern is that the BMI distribution has continually shifted to the right since the 1980's, suggesting that not only has the proportion of overweight children increased, but the degree to which children are overweight has increased substantially as well (Stifel, 2009).

However, it should be noted that the CDC growth charts were based on a reference population prior to the 1980's, when obesity prevalence was stable and not considered a public health threat (Ebbeling, 2008). Additionally, the BMI-for-age percentile cutoffs for overweight or obese children are not based on health risk due to the lack of clear risk-related criteria. In fact, there remains much debate as to which cutoffs and what charts need to be utilized. Although the CDC recommended using the sex- and age-specific 85th and 95th BMI percentiles as the arbitrary cutoffs to define childhood overweight and obesity in the United States (Flegal, 2006), the European Childhood Obesity Group favored the 90th and 97th percentiles (Poskitt, 1995), and the International Obesity Task Force (IOTF) proposed age and gender-specific cutoffs that would correspond to the widely used adult BMI values of 25 and 30 (Cole, 2000). These cutoffs vary in definition and reference populations resulting in wide-ranging prevalence estimates for overweight, obesity, or both (Flegal et al., 2001).

<u>Obesity and Health</u>

Obese adults are at increased risk for many serious health conditions, including coronary heart disease, hypertension, stroke, type 2 diabetes, and certain types of cancer (Ogden et al., 2010). Diseases associated with obesity accounted for 27% of the increases in U.S. medical costs between 1987 and 2001 (Thorpe et al., 2004). In 2006, obesity-related medical costs were estimated at $147 billion with obese persons paying $1,429 higher than persons of normal weight (Finkelstein, 2009). Obesity in adulthood is linked to comorbidities that have been attributed to estimates as high as 365,000 deaths annually in the United States (Mokdad, 2004). After adjusting for smoking status, annual death risk among nonsmokers increases by 12–40% among overweight and by 50–150% among those who are obese (Adams, 2006; Lawlor, 2006). Obesity also decreases life expectancy by as little as 0.8 (Reuser, 2008) to as much as 7 years (Peeters et al., 2003; Muennig, 2006) relative to their normal weight counterparts. However, the most staggering statistic highlighting the urgency needed to address this public health challenge is that obesity, and its related comorbidities, are the second leading cause of premature death in the United States after smoking (Biro, 2010).

Obesity in childhood often persists into adolescence and adulthood, especially for those children belonging to the highest BMI quartile (Guo et al. 1999) or those with an overweight parent (Whitaker et al. 1997). Furthermore, the pathological processes of obesity-related morbidities (e.g. cardiovascular disease and diabetes) begin in childhood (Biro, 2010). Therefore, the increase in prevalence and severity of overweight in children is of particular concern. The incidence of type 2 diabetes among adolescents, although not high, has increased by 10-fold since 1990 and may exceed that of type 1 diabetes among black and Hispanic adolescents (Fagot-Campagna, 2000). Fatty liver associated with excessive weight,

unrecognized in the pediatric literature prior to 1980, today occurs in about one in three obese children (Ebbeling, 2002). Among a nationally representative sample of 10,099 children (5-14 years), 39% of participants belonging to the obese category (BMI-for-age ≥95th percentile) had elevated LDL (≥90th percentile) (Freedman et al., 2007). There is growing evidence demonstrating that early stages of atherosclerosis, the leading cause of cardiovascular and cerebrovascular events, can appear in utero, infancy, or throughout childhood (Napoli, 1997; Napoli, 1999). Risk factors such as hypertension, insulin resistance, diabetes, or dyslipidemia are aggravated by obesity and further hasten development of atherosclerosis (Bacha et al., 2003). Even more disconcerting is that obesity in the adolescent years is associated with increased risk of multiple comorbidities in adulthood regardless of whether the obesity persists or not (Must, 1992; Ludwig, 2007). Although the exact mechanisms of this phenomenon are unknown, one possible theory is that obesity in childhood may cause damage to the vasculature that may be irreversible even after subsequent weight normalization in adulthood (Barton, 2012).

In addition to chronic systemic diseases, which often take decades to manifest, overweight children endure multiple social and psychological challenges throughout childhood. Research shows that obese youth face weight stigma from multiple sources including peers, educators and parents (Puhl, 2007). They are more likely to be socially isolated, have high rates of disordered eating, anxiety and depression (Sjöberg and Sjoberg, 2005) It also appears that overweight children are subject to higher frequency of bullying compared to their normal weight counterparts (Janssen, 2004; Hayden Wade, 2005). In a longitudinal study, consequences of being overweight in adolescence included lower rates of marriage, lower education attainment, lower family income, and higher poverty 7 years later (Dietz, 1998).

<u>Effects of Central Adiposity</u>

Most studies use BMI as a measure for adiposity, because it is a quick and inexpensive method to screen for overweight or obesity. However, assessing obesity solely on the basis of BMI can be problematic because obesity is defined as a condition characterized by excess fat accumulation and not just excess weight (Flegal, 2010). BMI provides no information on fat distribution and does not distinguish between lean and fat mass. These can be significant limitations since measures associated with abdominal/central adiposity have been more strongly linked to disease risk than BMI (Grundy, 2004). Central adiposity is a major component of the metabolic syndrome, which is strongly related to development for CVD and diabetes (Eckel, 2005). Intra-abdominal/visceral fat tissue, in particular, is related to insulin resistance and subsequent alterations in glucose homeostasis (Després, 2006a). For any given amount of total body fat, individuals with excess visceral adipose tissue, have a substantially higher risk for development of insulin resistance and manifestation of metabolic syndrome (Després, 2006b). There are three possible mechanisms by which visceral adipose tissue may contribute to an insulin resistant state; 1) hypertrophied visceral adipose tissue becomes resistant to lipolytic effects of insulin resulting in impaired non-esterified fatty acid (NEFA) metabolism; 2) reduced adiponectin levels causing alterations in glucose flux and lipid catabolism; and 3) reduced capacity to store excess adipose subcutaneously, leading to increase in fat deposition around the liver, pancreas and heart (ectopic fat) (Després, 2006a) Both altered NEFA metabolism and endocrine function are causally implicated in the association between visceral adipose tissue and the development of metabolic syndrome, which is often absent in individuals without visceral adiposity.

Clinical signs and symptoms associated with the metabolic syndrome has been identified in children and adolescents and appears to persist into adulthood (Terry and Huang, 2007). Some indications are that central adiposity among children may be increasing, independent of whole body weight (McCarthy, 2005; Moreno, 2005). Although DXA does not distinguish between visceral and subcutaneous fat tissue, it provides an accurate estimate of total abdominal fat mass with a minimal dose of radiation. In children, central adiposity measured by DXA was associated with higher plasma lipid and lipoprotein concentrations, blood pressure and left ventricular mass (Daniels et al., 1999). However, there are no established cutoffs to define excess central adiposity. Among adults, waist circumference is incorporated into the diagnosis of metabolic syndrome and predicts plasma lipids, lipoproteins and insulin levels (Pouliot et al., 1994; Conway et al., 1997; Taylor et al., 1998). Among children, two arbitrary waist circumference cutoffs (>0.5 waist-height-ratio and ≥75th percentile waist circumference-for-age) have been associated with increased insulin resistance and CVD risk factors (Savva, 2000). Savva and colleagues attempted to validate BMI, waist-to-height ratio, and waist circumference-for-age as predictors of cardiovascular disease risk factors in children. Among a large sample of 1037 boys and 950 females (mean age 11.40 ± 0.4), belonging to the highest quartile (≥75th percentile) for all measures was related to higher pathological values of blood low-density lipoproteins (LDL) and total triglycerides (TG). However, waist circumference-for-age and waist-to-height ratio were better predictors of LDL compared to BMI in a stepwise regression analysis. Nevertheless, these cutoffs have not been adopted by expert committees on childhood obesity assessment due to lack of comprehensive reference values. Nevertheless, assessment of central adiposity by imaging techniques or waist circumference may improve our understanding a child's future disease risk better than whole body fat mass or BMI.

Etiology of Obesity

The underlying causes of childhood obesity have been the subject of many studies in recent years and we are finally beginning to understand some of the complex genetic and environmental mechanisms involved. The most widely accepted theories implicate the interaction between genetic predisposition and an obesogenic environment that results in efficient energy storage (Moreno et al., 2010).

Parental influences on childhood obesity have been of interest since investigators have tracked obesity-related risk factors to earlier stages of development. Parental obesity appears to affect childhood adiposity through genetic predisposition. This was first confirmed by an adoption study in Danish children that showed a significantly higher correlation between the BMI of the adoptees and their biological parents compared to their adoptive ones (Stunkard, 1986; Sorensen et al., 1989; Sorensen et al., 1989). Another study among twins exposed to under-and over-feeding showed a considerable genetic component (~50%) in intake-related weight gain (Bouchard and Tremblay, 1997). Maternal obesity, in particular, appears to be strongly related to obesity in children. A European cross-sectional study of 3,306 children (5-7 years) and their parents showed that child BMI had a stronger correlation with maternal compared to paternal BMI ($r=0.25$ vs. 0.16, $p<0.01$) (Danielzik et al., 2002). These findings have been supported by similar epidemiological studies across the globe including Japan, Australia, and China (Luo and Hu, 2002; Sekine et al., 2002; Wang, 2002).

Environment-gene interactions have been proposed as a possible mechanism by which parents may influence risk for obesity in their children. Epigenetic traits are those that result in heritable phenotypic changes without alterations in underlying DNA sequence. The impact of such interactions may occur during and after intrauterine development. Evidence from animal

studies suggests that maternal consumption of a high fat diet during gestation is related to subsequent excess fat accumulation in rat pups (Wu, 2006), independent of diet intake. Other perinatal factors such as low protein intake have also been linked to higher birth weight (Whitaker, 1997). In humans, infants born to women with gestational diabetes have significantly higher fat mass than infants of women without gestational diabetes (Catalano et al., 2003). Collectively, the aforementioned studies support the hypothesis that early nutrition programming may have considerable effects on subsequent obesity development in children.

Dietary Components and Obesity

Although genetic susceptibility affects propensity for excess fat gain, it appears that environmental factors play a substantial role throughout development. Of the numerous risk factors known to modulate obesity and its persistence into adulthood, diet and physical activity are the main modifiable determinants of energy balance (Rodriguez and Moreno, 2006). Numerous components of diet have been the subject of research. However, few have examined this relationship in preadolescent children (Bowman et al., 2004; Bradlee, 2010).

Childhood and adolescence are critical periods of development characterized by continuous body growth, psychological changes, and onset of dietary habits that are likely to continue into adulthood (Boot et al., 1997; Lake, 2006). However, the relationships between body composition and energy intake related behaviors are reciprocal (Rodriguez et al., 2004). Excess adiposity develops when energy intake exceeds expenditure over a long period of time leading to accumulation of fat tissue. However, it is not clear which specific aspects of the child's diet need to be targeted for prevention. The major dietary factors previously studied include excess total energy intake (Atkin and Davies, 2000; Alexy et al., 2004), excess percent

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energy from fats (McGloin, 2002; Alexy et al., 2004) and contemporary diet patterns (Berkey et al., 2004; Bowman et al., 2004; Fisher et al., 2007).

Several studies have found a positive association between total energy intake and adiposity in children (Gillis et al., 2002; Jouret, 2007). Gillis et al. (2002) found that obese children and adolescents had significantly higher energy intake than their non-obese peers, independent of physical activity levels and other dietary factors. In a longitudinal study, further weight gain was reduced in children who decreased energy intake while increasing physical activity (Berkey et al., 2000). However, other studies found no relationship between energy intake and overweight or obese status (Maffeis et al., 1998; Andersen et al., 2005; Aeberli et al., 2007). The differences seen in studies may be attributed to a wide variation in measurement methods and instruments as well as underreporting of dietary intake by children (Livingstone, 2004). Epidemiological studies often rely on self-reported dietary intake without the help of a trained interviewer, therefore placing a larger burden on children to conceptualize portion sizes and recall food ingredients/preparation methods (Jain et al., 1996). In summary, much of the evidence supports the argument that excess energy intake is positively related to overweight and obesity (Rodriguez, 2010) However, the impact of energy intake on weight status, independent of physical activity or fitness, is still incompletely understood.

In addition to energy intake, the percent energy intake from fat and absolute fat intake have also been examined in relation to obesity (Magarey et al., 2001). One of the studies (Ortega et al., 1995) showed a positive association for percent energy from fat, but not with fat intake in absolute amounts, in a group of adolescents. Contrary to this finding, Gillis et al. (2002) reported a significant association between fat in grams and adiposity, but not with percent energy from fat. Magarey and colleagues conducted a prospective study that followed children from

birth to 15 years and found that fat, independent of total energy intake, was positively associated with subscapular skinfold thickness, but not with BMI or tricep skinfold thickness. Other studies have assessed the type of dietary fat, rather than the amount of total dietary fat. Obese children and adolescents have been shown to consume higher levels of saturated fat, independent of total energy intake and physical activity (Gillis et al., 2002). In addition, specific types of fats mediate weight gain. A study of 4-year-olds showed that children with adequate levels of dietary n-3 fatty acids were less likely to be obese compared to their counterparts who consumed low levels of n-3 fatty acids (Garemo et al., 2007). However, it is important to note that other studies have found no association between dietary fat intake and obesity (Davies, 1997; Maffeis et al., 1998; Berkey et al., 2000). Although total energy intake may play a more significant role in adiposity, it is important to examine the types of dietary fat that may have an effect on body composition independent of energy intake.

Positive associations between sucrose intake and BMI in young children have been previously documented (Garemo et al., 2007). Cross-sectional (Gibson and Neate, 2007) and prospective studies (Ludwig, 2001) have shown that consumption of sugar-sweetened beverages increases the risk for obesity (Olsen and Heitmann, 2009). It is proposed that sugar-sweetened beverages can lead to a disruption of the body's satiety mechanisms, while providing high amounts of calories in a short period of time (Malik et al., 2006). However, not all studies have found positive associations between sucrose consumption and obesity (Forshee et al., 2008).

Studying dietary patterns provides an important way of assessing combinations of nutrients, as well as, the frequency and environmental contexts in which foods are consumed (Quatromoni, 2002). Several interacting factors affect family and child food dietary patterns, including level of income, food availability, eating outside of home and family meal climate

(Finch et al., 2006; Moreno et al., 2010). However, the relative contribution of each of these as well as other factors on diet patterns is incompletely understood.

In adults, meal frequency and daily distribution of meals has been shown to have a relationship with overweight and obesity. Adults who report four or more eating episodes per day are less likely to be obese than those who report three or fewer episodes (Ma et al., 2003). This may also be the case with children (Toschke, 2005). In terms of daily energy intake distribution, obese children appear to eat less at breakfast, skip breakfast, and consume excess calories at dinner (Bandini et al., 1990; Livingstone and Robson, 2000; Serra Majem et al., 2003; Moreno et al., 2005). Decreases in breakfast frequency have been shown to prospectively predict BMI during adolescence and young adulthood (11-27 years) (Gillman et al., 2000; Niemeier et al., 2006). Positive eating habits such as consuming breakfast and the frequency of family dinners have been inversely related to fried foods and soft drink consumption (Gillman et al., 2000).

Assessment of typical snack choices of children suggests that they offer plenty of calories, but little nutritional value (Rodriguez et al., 2004; Moreno and Rodriguez, 2007; Ambrosini, 2009). Ambrosini at al. (2009) noted that "snacky" consumption pattern that was positively loaded for biscuits, buns, sweets, salted snacks, soft drinks, and nuts among 1631 Australian adolescents. This pattern was also inversely related to maternal level of education and positively related to TV viewing. In large longitudinal studies, snacking has been identified as an independent predictor of weight gain among children and adolescents as well (Field, 2004; Phillips et al., 2004).

Meeting nutrient needs from a variety of food groups is a component of overall diet quality. A recent study showed that diet quality is independently associated with weight status in

preadolescents (Jennings, 2011). Comparison of three types of diet quality indices (Diet Quality Index, Healthy Diet Indicator, and Mediterranean Diet Score) demonstrated that an inverse relationship exists between diet quality scores and obesity in 1,700 children between 9- and 10-years-of-age (Jennings, 2011). Both in adults and children, dietary variety that includes fruits and vegetables is associated with a healthy weight, while dietary variety from sweets, snacks and carbohydrates is associated with adiposity (Miller, 2008; Receveur, 2008). Understanding the behaviors that interact and influence dietary variety will be relevant to improving nutrition programs or interventions targeted towards children.

Measuring dietary intake in children can be challenging for multiple reasons, including poor conceptualization of portion sizes, inaccurate recall of foods eaten, lack of knowledge of food preparation methods, and selective under-/over-reporting of food intake (Livingstone and Robson, 2000). Furthermore, each of the three major instruments used in diet data collection (diet recalls, food frequency questionnaires, and diet records) have inherent measurement issues (Crawford et al., 1994). Children younger than 10-years have difficulty responding to food frequency questionnaires that require recalling intake over more than 1 day(Rodriguez, 2010). Using parents as proxies is not entirely reliable either, since they are often unaware of their children's dietary intake away from home.

Family Factors related to Obesity in Children

It is widely accepted that obesity is a complex and multifactorial condition influenced by genetic and environmental factors. Although the role of the home environment in the development of obesity has long been recognized, few studies have documented this relationship. The relationship between socioeconomic status (SES) and obesity remains inconclusive. It was

previously accepted that high SES groups in the United States are less likely to become overweight than their low-SES counterparts (Sobal, 1994; Sundquist, 1998; Wang, 2001). Recent trends show that an inverse relationship between SES and overweight status only exists for white children and a strong positive association existed in black adolescents (Wang and Zhang, 2006). Wang and Zhang (2006) also noted that the gap between ethnic groups became wider between 1971 and 2002, especially in adolescent girls. A review of the literature suggests that a third of the studies have found a positive relationship between SES and obesity, a third demonstrate a negative relationship and a third of the studies show no relationship at all (Strauss, 1999a). Variations may be due to the differences in ages of children studied and the measures of SES used. However, data from the Pediatric Nutrition Surveillance System indicate that the prevalence of obesity continues to increase in low-income preschool children among all ethnic groups (Mei, 1998). Studying specific aspects of households at different levels of SES may provide more relevant information for interventions.

Strauss (1999) examined the role of race, marital status, maternal education, and family income as well as standardized measures of home environment (using the Home Observation for Measurement of Environment Short Form) in the development of childhood obesity. Analysis of longitudinal data among 2913 normal weight children (0 to 8 years) participating in the National Longitudinal Survey of Youth (NLSY) (Strauss, 1999a) revealed that children raised in home environments with higher cognitive stimulation have the lowest rates of obesity independent of SES, race and maternal BMI. Lack of cognitive stimulation and emotional support has been shown to increase childhood overweight in other studies as well (Garasky et al., 2009). This suggests that specific stressors on the home environment may play a significant role in development of obesity.

Although a significant relationship appears to exist between parental and child weight the effect of parental level of education on childhood obesity is still unclear. Strauss (1999) found significant relationships between maternal education level, parental occupation, or marital status and incidence of obesity in their children. However, this relationship was not significant for the black children, whose obesity rates have increased the most over the past 3 decades. It is suggested that SES affects social and intellectual development by diminishing the capacity for supportive and consistent parenting (McLoyd, 1990). The personal resources of the mother such as here self-esteem, values, and occupational experience are reflected in the overall quality of the home environment (Menaghan, 1991) which is related to the cognitive stimulation of the child. Gundersen (2008) examined associations between food insecurity and maternal stressors with childhood overweight among low-income children. Analysis of 841 children from the 1999-2002 NHANES data revealed that younger children in food secure, low-income households experiencing higher levels of maternal stressors have a greater probability of being overweight than their food secure counterparts.

A household is considered 'food insecure' if it does not have the financial means to access enough food for all household members to sustain active and healthy living (Nord, 2010). Households that are more likely to be food insecure include those with low-income, headed by black non-Hispanic or Hispanic person, or headed by single parent (Nord, 2010). Some studies have found a positive relationship between food insecurity and child obesity (Casey et al., 2001; Dubois et al., 2006), while other studies have found either no relationship (Bhargava, 2008; Gundersen, 2008) or a negative one (Rose, 2006).

Although recent evidence shows no relationship between household food insecurity and child obesity, both conditions often coexist in low-income households (Gundersen, 2009).

Gundersen at al. (2009) analyzed 2,516 children (8-17 years old) from the 2001-2004 NHANES data and found that 56% of food insecure children were obese. There are many possible reasons why food insecure children could be obese including intake of cheaper calorically dense foods (Drewnowski and Specter, 2004), overeating when food is plentiful (Scheier, 2005), metabolic changes (Alaimo et al., 2001), parents overfeeding when food is plentiful (McIntyre et al., 2003) and maternal food insecurity during pregnancy (Laraia et al., 2006). Furthermore, the impact of food insecurity on child obesity appears to be different for preschool- versus school-aged children, with the former being more sensitive to it. It is possible that the nutritional outcomes of school-aged children (6-17 years) are less closely tied to family resources compared to pre-school children. School-aged children may be supplementing their consumption away from home by eating at school, at "friends" or "neighbors", or through income they earn through working (Bhattacharya, 2004).

In summary, there isn't sufficient evidence to support any single attribute of a child's diet or environment as an independent predictor of obesity. Dietary components that warrant further investigation include added sugars, types of fat, and overall energy intake. Often studies examining the nutrition-obesity relationship use BMI as an outcome and fail to measure actual fat mass or distribution. This is a significant limitation because whole body weight loss is often a daunting goal and focusing on a measure of fat distribution (e.g. waist circumference) may be a better therapeutic target (Després, 2006b). Additional research needs to be conducted to measure diet effects on direct measures of adiposity and fat distribution.

Media-related sedentary activities may include, but are not limited to, TV, computer and video game use (Henry J. Kaiser Family Foundation, 2010). Studies assessing video game and computer use have found little or no association with overweight or obesity in youth (Rey-López, 2008). Most studies have reported a positive association between TV viewing and adiposity. In adults, TV viewing predicts obesity, development of type 2 diabetes mellitus (Hu, 2001; Hu, 2003), and dyslipidemia (Fung, 2001). In children, TV viewing, independent of activity levels, has been associated with poor metabolic profiles (Sardinha, 2007). This relationship is strongest in children younger than 10-years-of-age suggesting that TV is a major risk factor for overweight and obesity in prepubertal children (Rey-López, 2008) In fact, reducing TV viewing has been an important part of successful obesity interventions among youth (Robinson, 1999; Epstein, 2000; Ludwig, 2004).

Current estimates of TV viewing indicate that youth watch an average of 4.5 hours of TV/day (Henry J. Kaiser Family Foundation, 2010). Child's access to video games increases daily screen time by 60 minutes for boys and 23 minutes for girls (Marshall, 2006). Computer use also increases screen time by 30 minutes/day. The high level of TV viewing is particularly troubling because children's TV exposure predicts overweight (Lumeng et al., 2006) and increases caloric consumption at the rate of 167 kilocalories per additional daily hour of viewing (Wiecha, 2006). This additional caloric consumption could be attributed to eating while watching TV, however, exposure to food advertising maybe have a more significant long-term contribution to excessive caloric intake. Zimmerman et al. (2010) studied associations between television content type and demonstrated that TV advertisement, rather than viewing time, is associated with obesity in children.

Children younger than 5 years see an average of 4000 television commercials (30 hours' worth) per year (Gantz, 2007). Several studies have shown that there is a lack of advertisements for nutritious foods on TV including programming geared to children (Wiecha et al., 2006). Analyzing nutrition content of foods advertised during weekend TV programming targeted at children (Saturday mornings) and adults (Sunday evenings) revealed that 97.5% of food commercials advertised unhealthy foods on Saturday mornings versus 78.3% on Sunday evenings (Kuribayashi et al., 2001). Foods were categorized as unhealthy if a serving of the food contained significantly high amounts of fat (>30% calories from fat), sugar (>30% calories from sugar), cholesterol (>35mg), or sodium (>360 mg). Children are influenced by food messaging, to the extent that food depictions affect food purchase requests (Donkin et al., 1993), their understanding of nutrition principals (Peterson, 1984), and their ability to self-regulate their intake of high calorie snacks (Dawson, 1988). It appears that no matter when children view TV, they are likely to be exposed to an abundance of advertisements for foods of low nutritional quality.

Previous studies have also shown a negative association between TV viewing and nutritional knowledge/beliefs. Signorielli and Staples (1997) provided 427 fourth- and fifth-graders with six pairs of foods and asked them which one of the choices was healthier. TV viewing predicted greater likelihood of selecting the unhealthy choice between the pairs, independent of child's gender, race, reading level, and parental education level. These studies suggest that children with higher TV viewing may have poor beliefs of nutritious foods. Harrison (2005) used a similar methodology to Signorielli & Staples (1997), with the additional measure of nutrition reasoning to study the impact of TV viewing in 134 first-third graders. In addition to asking children to identify the healthier food, they were asked to provide a reason for

why they thought that food was healthier. Results showed that TV viewing predicted subsequent

decrease in both nutritional beliefs and reasoning. However, this relationship was strong only for

diet-related foods. This was a meaningful find because it suggests that the link between TV

viewing and concepts of weight loss/diet foods is stronger than the link between TV viewing and

concepts of "regular foods" e.g. fruits, vegetables, and breads. Children are exposed to the

numerous weight loss/diet-related food product advertisements meant for adults. Most of these

lower calorie/fat/sugar items are marketed as "healthy" and can be a source of misinformation

for children. This is cause for concern, because children, unlike adults, are still in the process of

attaining peak bone and lean mass and what is considered "healthy" for adults is not always

healthy for the growing child.

Dieting Behaviors and Obesity

Often childhood obesity studies neglect assessment of the psychosocial influences on

children's dietary choices and how they may be influenced by media. Evidence suggests that

many adolescent girls who consider themselves overweight are actually of normal weight and are

engaging in weight loss-related behaviors (Strauss, 1999b). These studies also reveal gender and

ethnic differences in desire to be thin. Using the NHANES III data among 1932 adolescents,

Strauss (1999) reported that the children's own classification of whether they were overweight

correlated poorly with medical definitions of overweight. Of the children who considered

themselves overweight, 42% had a BMI less than the 85th percentile and 70% had a BMI less

than the 95th percentile. Only 28% of the children who considered themselves overweight had a

BMI between the 85th and 95th percentiles. Girls were more than twice as likely than boys to

want to weigh less, while the majority of the boys desired to weigh more. A higher percentage

of white females, compared to black females, considered themselves to be overweight and have attempted to lose before they reach puberty. Adolescent black females also appear to be less concerned about being overweight (Wilson et al., 1994), feel less societal pressures to be thin, and are seven times more likely to report that they are not overweight (Kemper et al., 1994) compared to their white peers. Similarly, adolescent black males select larger ideal body sizes and are more likely to report being overweight less frequently than their white counterparts (Thompson, 1996). Only a few studies have examined desire to be thin in children prior to puberty. However, it has been reported that children acquire cultural values to beauty prior to adolescence and their desire to be thin precedes the desire to be beautiful (Feldman et al., 1988). In a cross-sectional study survey of first through third graders, 42% of females (6-7 years of age) preferred a body type different from their own (Collins 1991). Given that much of culture and media glorifies thinness, children and adolescents who feel that they are overweight may be engaging in harmful weight loss behaviors e.g., skipping meals and binge-eating (Neumark-Sztainer, 1999). These behaviors may produce the counterproductive effect of further weight gain (Field, 2003; Neumark Sztainer, 2007).

Fitness and Obesity

The reasons for the high rates of obesity in the U.S. children have been debated on the two sides of the energy balance equation: energy intake and energy expenditure (Schneider et al., 2007). Some researchers attribute obesity to excessive intake (Utter et al., 2003; Bleich et al., 2008), while others suggest that the current sedentary lifestyles of children and adolescents are primarily responsible for the increased obesity rates (Prentice, 1995). As discussed previously, dietary intake in children has been related to obesity in many studies, but not all. Therefore, it is

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necessary to study sedentary behaviors in concert with diet to assess their collective influence on weight status. Both obesity and physical inactivity have similar associations with clinical risk factors (e.g. blood pressure, fasting blood glucose and inflammatory markers (Fagard, 1999; Wei et al., 1999; Church, 2002).

Furthermore, low fitness levels may be independently related to CVD risk among children. Results from 9-18-year-olds participating in the Quebec Family Study suggest that low levels of aerobic fitness were related to higher blood lipids compared to their higher fit counterparts within the same BMI category (Eisenmann, 2005). Multiple studies suggest that physical activity is related to decreased %body fat in children (Rowlands et al., 1999; Epstein, 2000). Rowlands and colleagues studied associations between children's activity (8-10-year-olds), aerobic fitness, and adiposity. Activity measured by pedometers correlated positively with fitness and negatively with adiposity. Epstein and colleagues utilized an intervention targeting sedentary behaviors in 8-12-year-olds. Results showed decreases in sedentary behaviors or increases in physical activity were associated with significant decreases in %body fat and improved fitness.

Majority of studies on obesity have failed to account for physical activity and cardiorespiratory fitness among their participants. The most common method of assessing physical activity involves relying on self-report questionnaires which are subject to over reporting and subsequent misclassification (Blair, 2004). Using maximal exercise tests to measure cardiorespiratory fitness provides an objective evaluation of an individual's activity patterns (Paffenbarger et al., 1993). Given that physical activity is closely related to obesity, there is a need to utilize accurate methods for assessment of both when studying the effects of behavioral factors on disease risk.

RESEARCH JUSTIFICATION

Targeting prevention in children is essential to reducing the life-long health burden associated with obesity. In order to design effective interventions, it essential to understand the dietary and media use determinants that contribute to the development of central adiposity at critical developmental stages of childhood. Television viewing has long been studied as a physical activity-related practice (Eisenmann, 2008; Vicente-Rodríguez, 2008) . However, emerging evidence suggests that this practice may also have significant nutritional consequences as well (Harrison, 2005; Miller, 2008; Zimmerman, 2010). In addition to predicting higher BMI-for-age, TV viewing is source of nutrition misinformation and studying its influence on nutrition beliefs and reasoning may provide a link between children's dietary choices and media use (Signorielli and Staples, 1997; Harrison, 2005). Although several studies have assessed diet in relation to obesity, there is limited knowledge regarding the specific components that should be targeted. Furthermore, previous studies have failed to assess fitness and fat distribution when evaluating the role of behavioral factors in the development of childhood obesity. Cardiorespiratory fitness, determined by maximal oxygen consumption (VO_{2max}), is stronger than self-reported physical activity as a predictor of health outcomes because it is less prone to misclassification (Blair, 2004). Additionally, abdominal adipose tissue (central adiposity) measured using DXA has been previously correlated with higher plasma lipids, elevated blood pressure, and insulin resistance in children (Daniels et al., 1999; Morrison et al., 1999; Krekoukia, 2007). There is mounting evidence that children with waist circumference-for-age and waist-to-height ratio above the 75th percentile or greater than 0.5, respectively, have dyslpidemia and higher insulin resistance that children below these cutoffs (Savva, 2000;

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Ashwell, 2005). These studies suggest that central adiposity may represent the most-clinically relevant distribution of body fat to assess in children, as is the case with adults.

The research proposed here will examine associations between the prepubertal child's media use, diet and body fat distribution. Using DXA will provide an accurate method of assessing total body and central adiposity. The interaction between diet and media use will be examined in order to assess whether nutrition beliefs play a role in this relationship. Outcomes will be analyzed while considering the child's personal attributes e.g. age, gender, and pubertal staging. Finally, we will develop regression models that predict measures of central adiposity using diet and media use. There is a dearth of knowledge regarding behavioral factors related to central obesity among preadolescents. Studying these relationships during this stage of development is critical given that obesity persists into adulthood for a majority of obese adolescents (Dietz, 1997; Engeland, 2004). Additionally, identification of dietary and media use components related to central adiposity will provide important targets for behavioral intervention.

The *overall objective of this research* is to determine how media use and diet intake, independently or in concert, affect central adiposity in prepubertal children. Our *central hypothesis* is that poor diet quality is related to increased central adiposity, independent of cardiorespiratory fitness. **Figure 1** illustrates the aims and expected relationships between the major outcomes of the study.

Aim 1: Determine media use components related to central adiposity

The overall objective of this aim is to determine how total screen-time and components of media use (TV, computer or video game) relate to central adiposity in prepubertal children. *The working hypothesis* for this aim is that total screen-time and TV viewing are directly related to

central adiposity, independent of fitness level. It is also expected that children with high TV viewing will have lower overall nutrition beliefs.

Aim 2: Determine dietary components related to central adiposity

The overall objective of this aim is to determine how dietary intake relates to central adiposity in prepubertal children. *The working hypothesis* for this aim is that dietary components associated with lower diet quality (e.g., added sugars and saturated fat) will be related to increased central adiposity. It is expected that these relationships will remain significant after controlling for fitness and energy intake.
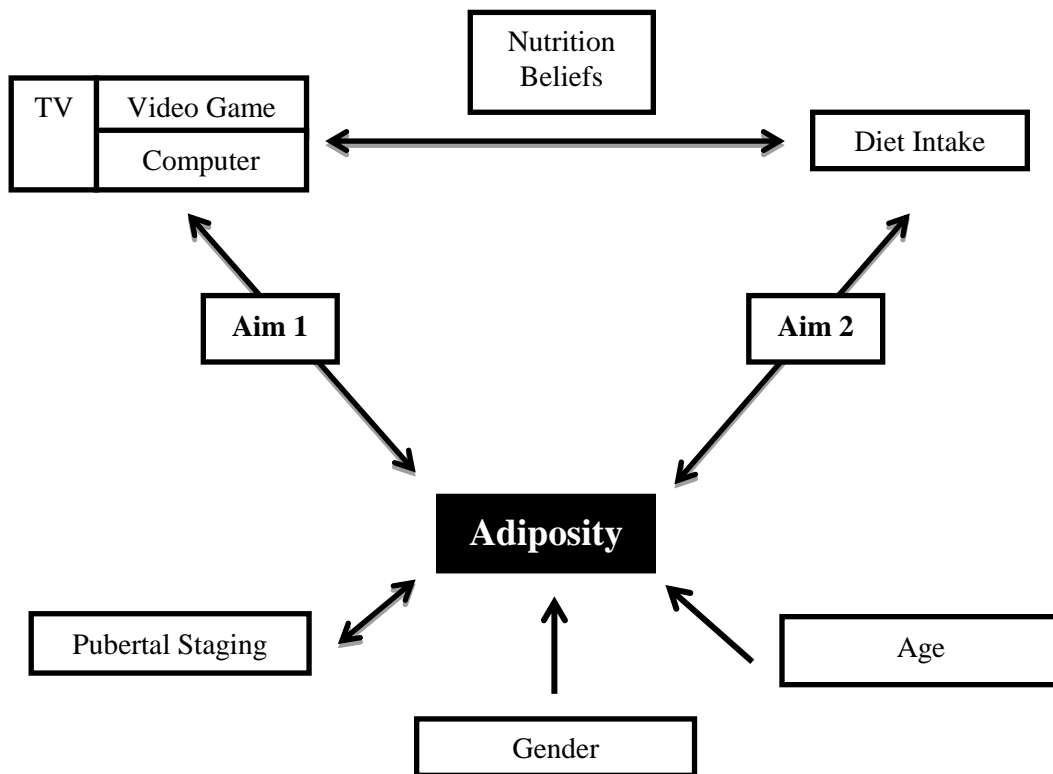
Figure 1: Relationships between media use, diet, and adiposity

MATERIALS & METHODS

Study Design and Participants

A four-year cross-sectional study (2008-2011) was undertaken to explore the relationships between demographic variables, diet, screen time, and central adiposity in a group of prepubertal children. Participants were recruited from an on-going NIH-funded after-school physical activity research trial (FITKids; HD055352; Charles Hillman, principal investigator). **Figure 2** illustrates the four waves of the study and sequence in which measures were added. The study was approved by the Institutional Review Board of the University of Illinois and informed consent was attained from parent and child. All measures were assessed at baseline to avoid any effects of the intervention.

Measures

Data was collected over two days of testing. On day 1, either parent was asked to complete a questionnaire on family demographics and their child's media use (TV, computer, and video game viewing). Following a cardiorespiratory fitness test, the child was interviewed and asked to report his/her dietary intake using a 24-hour diet recall. Day 2 testing involved collection of child's anthropometric measures and body composition using DXA. Additional measures of diet and media use were included in the final year of the study (wave IV). Wave IV additions included Children's Eating Attitudes questionnaire (ChEAT), 3-day food journal, and a 2-day media log.

Demographic Information: Parents responded to a demographics and health history questionnaire (**Appendix A**) to report their level of education, household income and occupational status. Additional questions included child's race, birth weight and type of school lunch (free/reduced price/paid). SES was determined by creating an index based on: (1) participation in free or reduced-price meal program at school, (2) the highest level of education obtained by the mother and father, and (3) number of parents who worked full-time.

Media use: Over the first three waves of the study, child's media use was measured using a section of the demographical questionnaire (Appendix A) in which parents reported their child's weekday and weekend media use (TV, video games, and computer). However, a 2-day take-home media log was introduced for wave IV (**Appendix B**). The 2-day media log was adopted from a previous study (Henry J. Kaiser Family Foundation, 2010) and allows children to report upto 12 media-related activities over half hour segments of the day (6am-12pm).

Dietary Intake: With parental assistance, children reported intake of all foods and beverages by responding to one 24-hour recall (**Appendix C**). The Nutrition Data Systems for Research 2010 (Minneapolis, MN) was used to analyze all intake data. A three-day food record (**Appendix D**) was introduced in wave IV as an additional high quality measure of diet intake (Crawford, 1994).

Nutrition Beliefs : Children responded to a Nutrition Beliefs and questionnaire (**Appendix E**) modified from previous work by Harrison (2005). Diet and fat-free versions of common foods are included to capture the child's beliefs and related to foods advertized as weight-loss or "healthier" options for adults.

Dieting Behavior: Children's dieting behaviors were assessed using children's healthy eating attitudes test (ChEAT) (Maloney et al. 1988). This is a self-report test that consists of subscales related to disturbed eating attitudes (Appendix F).

Pubertal Staging: Pubertal staging was determined by a modified Tanner Staging system (Appendix G) (Tanner, 1962; Taylor, 2001). Parents were allowed to complete the questionnaire in privacy or allowed to take home and return on a later date.

Anthropometrics: Child's barefoot standing height was measured to the nearest 0.1 cm with a stadiometer. Body weight was be measured on a calibrated balance scale with participants wearing shorts and a t-shirt. *Waist and hip* circumferences was used to further assess the child's degree of central adiposity. Waist circumference was measured as the minimum circumference between the top of the iliac crest and the distal end of the rib cage along the midaxillary line and at the umbilicus. Hip circumference was measured as the maximal girth of the hips region (Maffeis et al., 2001). These measures were recorded in the Anthropometric form (Appendix H).

Body Composition: Body composition was assessed by DXA (Hologic QDR 4500, Bedford, Massachusetts). DXA measures included total and central adiposity. Central adiposity was defined as the amount of fat mass located between lumbar vertebral bodies L1 and L4 (Svendsen et al., 1993; Treuth et al., 1995). DXA adds minor risk to participants with minimal radiation exposure of one 1 mrem. At this dose level, no harmful effects of radiation have been documented and the risk is negligible.

Cardiorespiratory Fitness Assessment: Maximal oxygen consumption (VO_{2max}) was measured using a computerized indirect calorimetry system (ParvoMedics TrueMax 2400) with averages for oxygen uptake (VO_2) and respiratory exchange ratio (RER) assessed every 20 seconds. A modified Balke protocol (Gordon, 2009) was employed using a motor-driven treadmill at a constant speed with increases in grade increments of 2.5% every 2 minutes until volitional exhaustion. Heart Rate (HR) throughout the test and ratings of perceived exertion (RPE) was assessed every 2 minutes using the children's OMNI scale (Utter and UTTER, 2002). Relative peak oxygen consumption was expressed in ml/kg/min and was based upon maximal effort as evidenced by: 1) a plateau in oxygen uptake corresponding to an increase of less than 2 ml/kg/min despite an increase in exercise workload; 2) a peak heart rate (HR) $\geq$ 185 bpm (ACSM, 2006) and a HR plateau (Freedson and Goodman, 1993); 3) RER $\geq$ 1.0 (Bar Or, 1983); 4) ratings on the children's OMNI scale of perceived exertion $\geq$ 8 (Utter and UTTER, 2002). VO_{2max} percentile was determined according to previously provided normative data (Shvartz and Reibold, 1990).

Statistical Analyses

      All data analyses were conducted using SPSS version 19.0 (SPSS, Inc., Chicago, IL). Normality in anthropometric, DXA, diet and media variables was determined using Q-Q plots and Shapiro-Wilk. Log transformations were utilized, as needed. Independent t-tests and one-way ANOVA were used to determine differences between groups. Males and females were grouped together when studying relationships between diet and media variables since there were no differences in overall screen-time or energy intake by gender. However, females and males differed significantly on multiple body composition variables including the primary outcome of

central adiposity, therefore, further analyses related to body composition were separated by gender.

Initial Pearson product-moment correlations were conducted between measures of body composition (i.e., central adiposity [FM-abd], whole body % fat mass [WB %FM], BMI, waist-to-height ratio [WHtR]), demographic factors (i.e., age, sex, race, socioeconomic status [SES], VO2max percentile), and pubertal timing. Partial correlations were conducted between media and diet variables and body composition. The dietary components selected for analyses were total energy intake, macronutrients (protein, fat, and carbohydrates), saturated fats, added sugars, glycemic load, and cholesterol saturated fatty acid index. These components were selected based on prior studies in the literature implicating them in development of obesity in varying degrees. Finally, standard linear regression analyses were conducted for each gender to predict FM-abd, WHtR, and WB %FM. Pubertal timing, age and VO_{2max} percentile were included in the initial steps of all regression analyses due to their established relationship with adiposity in children. Diet and media measures were then added to the subsequent models. Data are expressed as mean ± standard deviation in text and tables. All significance tests were conducted at the alpha=0.05 level.

Figure 2. Outcomes assessed with each wave of the FITKids study

Wave I (2008)	Wave II (2009)	Wave III (2010)	Wave IV (2011)	N
Fitness				229
Body Composition				217
Media – Parent Reported				219
	Diet Recalls			152
		Nutrition Beliefs		96
			Diet Records	32
			Dieting Behaviors	38
			Media log – Child Reported	28

RESULTS

Subject Demographics

Demographic characteristics from all participants (N=229; 113 female, 116 male) separated by gender are reported in **Table 1**. The majority of the participants were white and 40% were of lower SES. Over half of males and females belonged to Tanner stage 1 with a larger proportion of males at Tanner stage 2 compared to females (40% vs. 33%). However, there were differences in household income with a larger proportion of females belonging to households earning between $80,000-99,999 and more males belonging to households earning between $40,000-59,999.

Anthropometrics

Anthropometric characteristics from all participants (N=229; 113 female, 116 male) separated by gender are reported in **Table 2.** Although there was no difference in age, females had significantly higher weight (p=0.02), waist circumference (p=0.01), waist-to-height ratio (p=0.02), and BMI (p=0.01) than their male counterparts. Children were classified by BMI-for-age using the CDC (2000) growth charts and these results are summarized in **Table 3**. Although the proportion of normal weight children was similar across gender groups, a larger proportion of females were classified as obese compared to males (32% vs. 23%).

Body Composition by DXA

Utilization of DXA allowed for further classification based on WB %FM and the results are summarized in **Table 4**. Findings confirmed the group classifications made by BMI-for-age,

with a higher proportion of females being classified as obese compared to males (28% vs. 18%).

Females had significantly higher whole body fat (p<0.001), total mass (p=0.01), and WB %FM

(p<0.001) (**Figures 3 & 4**). Furthermore, females had significantly higher FM-abd (p<0.001)

compared to males (**Figure 5**). Given the significant adiposity differences among females and

males, additional analyses were conducted separately based on gender. Bivariate correlational

analyses among females showed that pubertal staging is positively related to WB %FM (r=0.37,

p<0.001) and FM-abd(r=0.48, p<0.001) (Table 5). Conversely, no statistically significant

relationship was observed between pubertal staging and adiposity measures among males

(p=0.32 and p=0.08) (**Table 6**). However, cardiorespiratory fitness was inversely related to FM-

abd among females (r=-0.59, p<0.001) and males (r=0.47, p<0.001).

Fitness

There were no significant differences between male and female meanVO$_{2max}$ percentile

(p=0.82). VO$_{2max}$ percentile comparisons between groups based on weight-status (BMI-for-age)

are summarized in **Figure 6**. Normal weight children had significantly higher VO$_{2max}$ percentile

than both overweight (p<0.001) and obese (p<0.001) counterparts. However, the difference

between overweight and obese children was not significant (p=0.05).

Media Use

Differences in media consumption between females and males are summarized in **Figure

7**. Males have higher weekly videogame and weekend screen time compared to females.

However, there were no differences in TV and computer time between genders. Among females,

weekend TV time was related to increased FM-abd (r=0.17, p=0.03) and WHtR (r=0.22,

p<0.001), after controlling for the influence of fitness (**Table 7**). No media use variables showed significant correlations with measures of adiposity after controlling for fitness among males (**Table 8**). Within group differences in FM-abd were assessed based on the American Academy of Pediatrics recommendation of less than 2 hours of TV/day (**Figure 8**) (Strasburger, 2011). Females who watch more than 2 hours of TV/weekday had significantly higher FM-abd compared females who met the recommendation (p=0.03). Differences in FM-abd were not significant among males across the TV use cutoff of 2 hours (p=0.09). Media use was also assessed using 2-day media logs among wave IV participants. However, response rates were low with only 28 participants returning the logs on day 2 of testing. Furthermore, all media variables measured by media logs displayed deviations greater than their means and were therefore excluded from analyses.

Dietary Intake

Descriptive analyses of the 24-hour diet recalls are summarized in **Tables 9** and **10**. Intakes among both groups exceeded recommendations for calories from saturated fat and sodium. Additionally, children failed to meet their recommended intakes for several nutrients including protein, fiber, and potassium. Although there were no significant differences in macronutrient (protein, fat, and carbohydrates) intake between males and females (**Figure 9**), both groups reported consuming higher than recommended energy intake. **Table 11** summarizes comparisons between intake reported by 24-hour recalls and 3-day food records during wave IV of the study. There were no significant differences between intakes (p>0.05) suggesting agreement between the two assessment methodologies.

Within gender differences in energy intake were assessed based on BMI-for-age classification as normal weight (5th-84th percentile) and overweight or obese ($\geq 85^{th}$ percentile). Overweight females had higher energy intake (p=0.04) compared to their normal weight peers (**Figure 10**). However, there were no significant differences in energy intake between overweight males and normal weight males (p=0.84) (**Figure 11**). Diet differences among females were further assessed by comparing those above or below the waist circumference-for-age cutoff (75th percentile) (**Figures 12** and **13**). Females above the cutoff had significantly higher CSI (p=0.04) and added sugars (p<0.001) compared to females below the cutoff. Partial correlations between diet variables and body composition are summarized in **Tables 12** and **13**. The CSI was the only dietary variable related to higher FM-abd among females. This relationship remained significant after controlling for both fitness and energy intake (r=0.26, p=0.03). However, no diet-body composition relationships remained significant after controlling for fitness and energy intake among males.

Relationships between diet and media use

Females and males were analyzed as one group when assessing relationships between media use and dietary intake. Bivariate correlation of media use and diet showed that weekday TV time was positively related to energy intake (r=0.21, p<0.001), cholesterol (r=0.15, p=0.04), added sugars (r=0.20, p=0.02) and CSI (r=0.17, p=0.03). Total screen time on weekdays was related to increased cholesterol (r=0.17, p=0.02), saturated fatty acids (r=0.17, p=0.18) and added sugars (r=0.17, p=0.03). However, after controlling for screen time and energy intake, weekend TV time was related to increased added sugars (r=0.15, p=0.04) and decreased CSI (r=-0.15, p=0.04).

<u>Nutrition Beliefs</u>

Reliability analysis of the nutrition beliefs questionnaire is summarized in **Table 14**.

Overall, the questionnaire had moderate internal consistency based on the Cronbach alpha score

of 0.63. After removing two items, the diet vs. high energy/low quality subscale (**Table 15**) had

high internal consistency (alpha=0.86) and was utilized in further analyses. The questionnaire

was scored by awarding a point for selecting the nutrient dense/healthy food item in all

comparisons. For comparisons between diet and high-energy/low-nutrient foods, participants

were awarded one point for selecting the diet version of the food instead of the high-energy/low-

nutrient option. Therefore, high overall scores on the questionnaire reflect increasing selection

of healthy foods and low scores indicate increased selection of the high-energy/low-nutrient food

items. Although there were no significant relationships with energy intake, bivariate correlations

revealed that total nutrition belief scores were inversely related to screen time/weekday (r=-0.27,

p=0.04) among females (N=52). Furthermore, nutrition belief scores were related to increased

intake of vitamin D (r=0.37, p=0.01) and calcium (r=0.42, p=0.003) and reduced energy intake

from fat (r=-0.31, p=0.02). Among males (N=39), increased scores on the diet vs. high-

energy/low-nutrient subscale were inversely related to intake of energy from fats (r=-0.35,

p=0.02) and saturated fats (r=-0.30, p=0.03). These analyses are summarized in **Tables 16** and

17.

<u>Dieting Behaviors</u>

Only 38 participants responded to the questions corresponding to the dieting subscale of

the ChEAT (Cronbach alpha=0.76). Therefore, both genders were grouped together for further

analyses. Bivariate analyses revealed that dieting subscale scores were related to increased FM-

abd, WHtR, WB %FM, and BMI. Diet data was only available for 30 of these respondents.

Increasing scores on the dieting subscale were related to increased carbohydrate intake (r=0.32,

p=0.04) and decreased intake of cholesterol (r=-0.32, p=0.04).

Regression Models

Given the significant differences in body composition between females and males,

regression models were developed for each gender group. Standard linear regression models

were performed to assess the independent effects of dietary variables on FM-abd, WHtR, and

WB %FM. Age, pubertal staging and VO_{2max} percentile were included in the models of all

regression analyses due to prior research indicating their relationship with adiposity in children.

Dietary variables were then added to the subsequent models. The α level for statistical

significance was set at 0.05.

Predictors related to FM-abd were analyzed and the complete results are displayed in

Tables 18 and **19**. Among females, pubertal staging alone accounted for 23% of the variance in

FM-abd. However, addition of age did not significantly improve the model. The addition of

fitness in model 3 significantly improved the model and explained an additional 22% of the

variance. Model 6 includes energy intake, added sugars and CSI in addition to all prior variables

and accounts for 53% of the variance in FM-abd. The strongest predictors of FM-abd were

pubertal staging (β=.418, p<0.001) and fitness (β=-.405, p<0.001). Among males, pubertal

staging was not a major contributor to FM-abd (β=-.044, p=0.652). However, age was a positive

predictor (β=.306, p=0.005) and fitness was a negative predictor (β=-.453, p<0.001) of FM-abd.

Subsequent addition of diet variables only accounted for an additional 0.5% of the variability in

FM-abd.

Standard linear regression was also performed to determine the predictive ability of energy, added sugars, and CSI on WHtR. **Table 20** summarizes the findings among females. The results were similar to those developed for FM-abd with the overall model accounting for 53% of the variability in WHtR. Among males (**Table 21**), after addition of all variables, fitness was the strongest predictor of WHtR (β=-.331, p=0.005).

Regression analyses predicting WB %FM are summarized in **Tables 22** and **23**. Among females, pubertal staging alone accounted for 13% of the variability in WB %FM. Model 5 suggests that, energy from protein was a positive predictor of whole body adiposity (β=.265, p=0.007). However, when energy from fat is included in the model, the contribution of energy from protein becomes non-significant. The overall model accounted for 52% of the variability in WB %FM. Among males, age (β=.335, p=.001) and fitness (β=-.427, p<0.001) remained the strongest predictors of WB %FM.

Table 1. Participant demographics and background

		Females (%)	**Males (%)**
Race	Asian	12	12
	Black	25	26
	White	47	47
	Other or Mixed	12	14
	Missing	4	1
Pubertal staging	Tanner Stage 1	64	58
	Tanner Stage 2	33	40
	Missing	3	2
Socioeconomic Status	Low	45	44
	Moderate	23	20
	High	31	35
	Missing	1	1
Household Income	≤19,999	21	15
	20,000-39,999	24	26
	40,000-59,999	11	24
	60,000-79,999	14	12
	80,000-99,99	16	8
	≥100,000	12	13
	Missing	2	2

Table 2. Anthropometric and fitness differences between females and males

	Females (N=113)	Males (N=116)
Birth weight (kg)	3.41 ± 0.80	3.47 ± 0.97
Age (years)	8.89 ± 0.59	8.80 ± 0.58
Weight (kg)	38.6 ± 11.3*	35.0 ± 11.57
Height (cm)	136.8 ± 6.93	134.9 ± 7.87
Waist Circumference (cm)	67.03 ± 10.24*	63.76 ± 8.54
Waist-to-height ratio	0.49 ± 0.06*	0.47 ± 0.065
BMI (kg/m^2)	19.9 ± 4.06*	18.40 ± 4.07
VO$_{2max}$ percentile	19.14 ± 22.04	18.51 ± 20.38

All values presented as Mean ± SD
* Statistically significant difference between groups (p<0.05)

Table 3. Distribution of weight status by BMI-for-age percentiles

	Females (%) (N=113)	Males (%) (N=116)
Underweight (<5th)	3	3
Normal Weight (5-84th)	47	52
Overweight (85-94th)	18	22
Obese (≥95th)	32	23

Participants were categorized using the Centers for Disease Control and Prevention growth charts (Kuczmarski et al., 2000).

Table 4. Classification whole body %adiposity as measured by DXA

	Females (%) (N=105)	Males (%) (N=109)
Low	1	0
Average	47	58
High	20	18
Obese	28	18
Missing	4	6

Participants were categorized based on previously provided whole body %adiposity reference values (Heyward, 2004)

Figure 3. Females have higher whole body fat and total mass than males
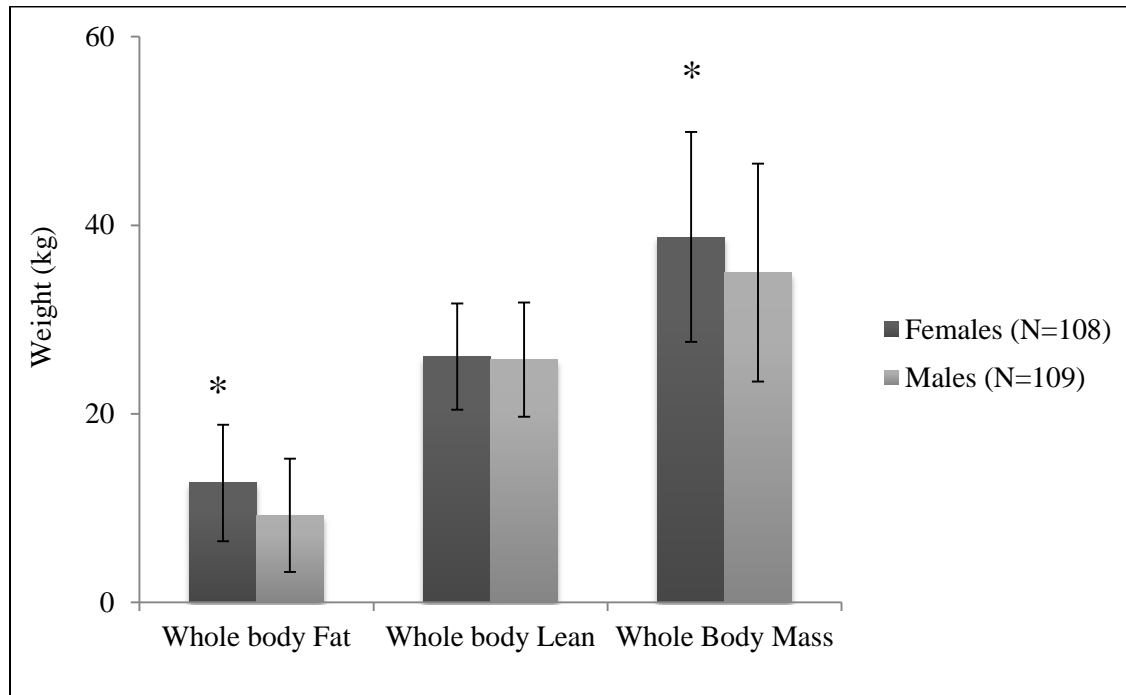
All values presented as Mean ± SD
* Statistically significant difference between groups (p<0.05) as determined by one-way ANOVA.

Figure 4. Females have higher whole body % adiposity than males
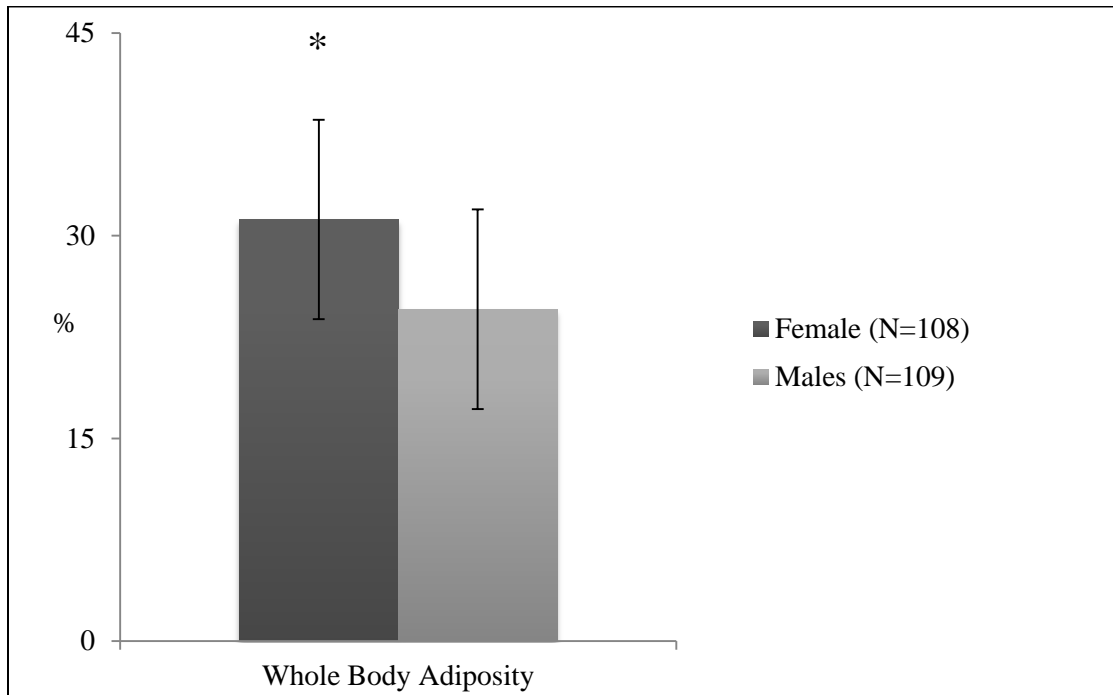
All values presented as Mean ± SD
* Statistically significant difference between groups (p<0.05) as determined by one-way ANOVA.

Figure 5. Females have higher central adiposity than males

All values presented as Mean ± SD
* Statistically significant difference between groups (p<0.05) as determined by one-way ANOVA.

Figure 6. Normal weight children have higher fitness than overweight and obese children

All values presented as Mean ± SD
* Statistically significant difference between groups (p<0.05) as determined by one-way ANOVA. Participants were categorized using the Centers for Disease Control and Prevention growth charts (Kuczmarski et al., 2000).

Table 5. Pubertal staging and age are related to increased central adiposity among females (N=106)

	1	2	3	4	5	6	7	8
1. Central Adiposity	___							
2. Waist-to-height ratio	.86**	___						
3. Whole body % Adiposity	.93**	.76**	___					
4. Body Mass Index	.86**	.85**	.76**	___				
5. VO$_{2max}$ percentile	-.59**	-.50**	-.61**	-.54**	___			
6. Age	.19*	.06	.11	.16*	-.06	___		
7. Socioeconomic Status	-.10	-.21*	-.08	-.17*	.19*	-.01	___	
8. Pubertal Staging	.48**	.46**	.37**	.51**	-.29**	.29**	-.12	___

**significant at the 0.01 level (one-tailed)
*significant at the 0.05 level (one-tailed)

Table 6. Pubertal staging is not related to central adiposity among males (N=107)

	1	2	3	4	5	6	7	8
1. Central Adiposity	___							
2. Waist-to-height ratio	.84**	___						
3. Whole body % Adiposity	.94**	.80**	___					
4. Body Mass Index	.86**	.83**	.78**	___				
5. VO$_{2max}$ percentile	-.48**	-.39**	-.53**	-.46**	___			
6. Age	.26**	.09	.20*	.20*	-.09	___		
7. Socioeconomic Status	-.09	-.11	-.10	-.10	.240**	-.07	___	
8. Pubertal Staging	-.05	-.12	-.15	-.02	.00	.18*	-.01	___

**significant at the 0.01 level (one-tailed)
*significant at the 0.05 level (one-tailed)

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Figure 7. Males have higher videogame and weekend screen time than females
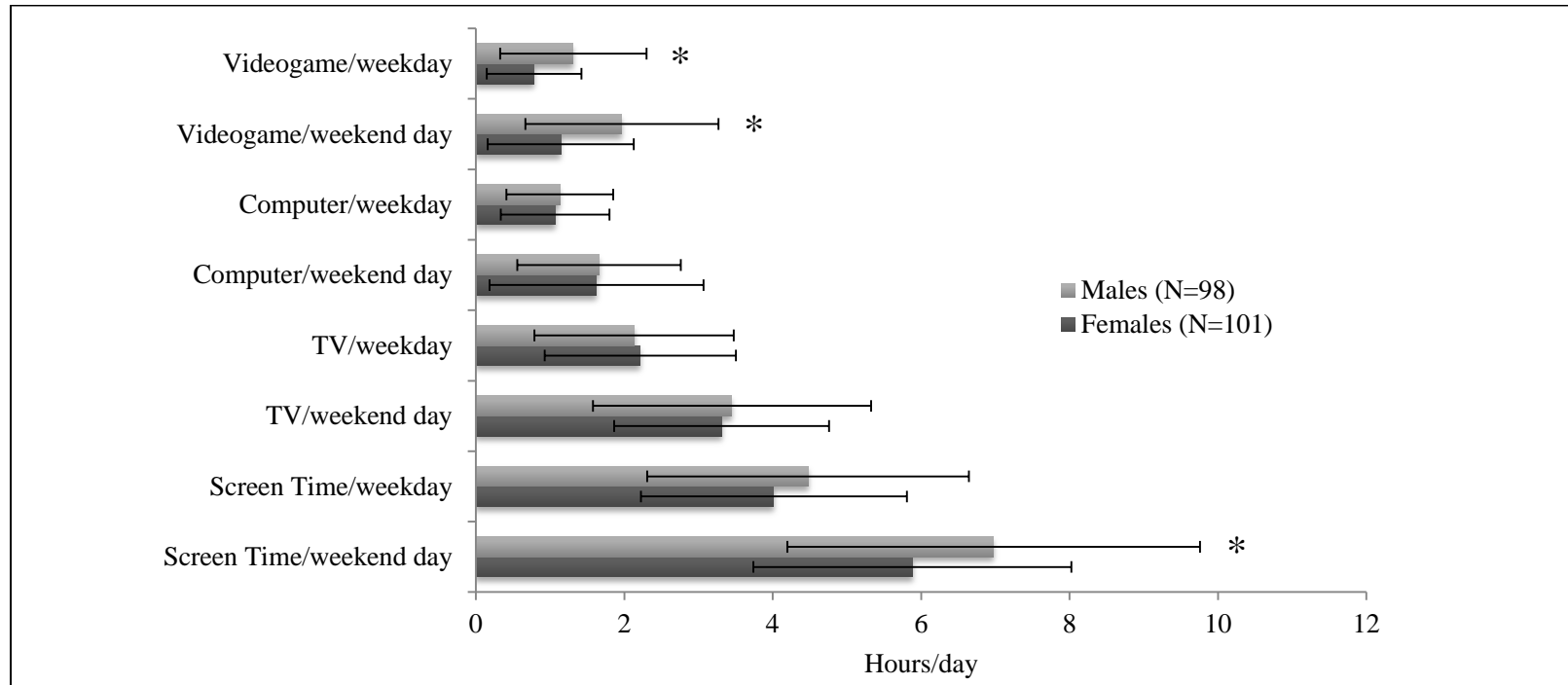
All values presented as Mean ± SD
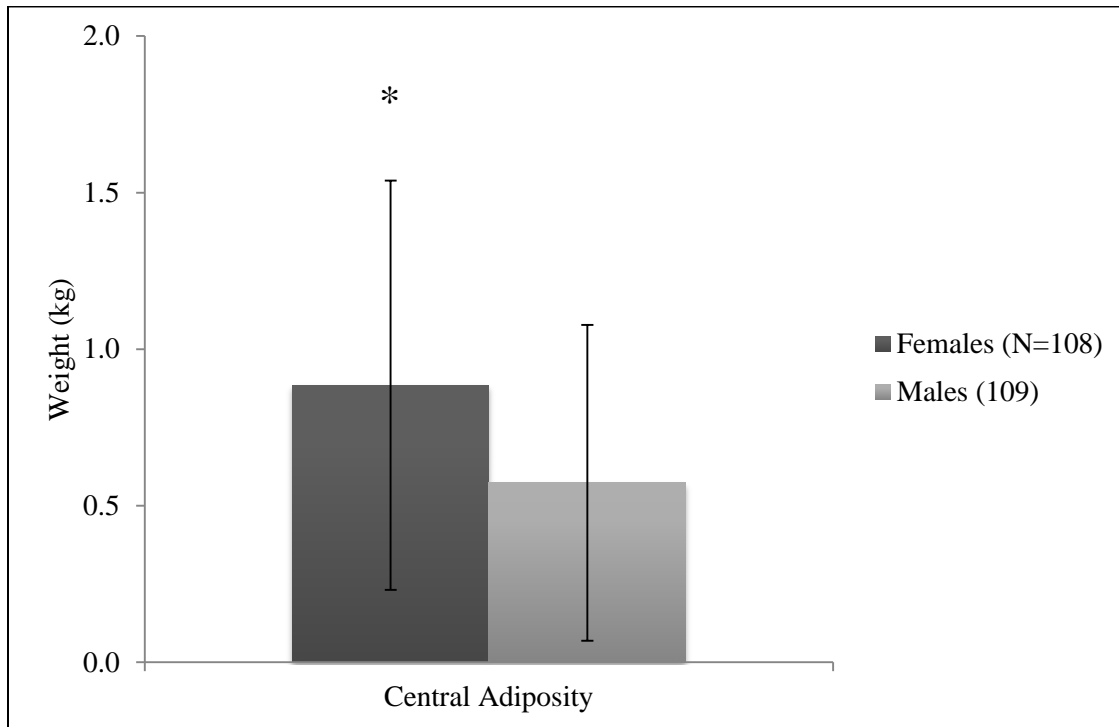* Statistically significant difference between groups (p<0.05) as determined by one-way ANOVA.

Table 7. Weekend TV time is related to increased central adiposity among females (N=99), after controlling for fitness

	1	2	3	4	5	6
1. Central Adiposity	___					
2. Waist-to-height ratio	.82**	___				
3. Whole Body % Adiposity	.88**	.72**	___			
4. Body Mass Index	.81**	.79**	.68**	___		
5. Television/weekday	.06	.13	.04	.15	___	
6. Television/weekend day	.17*	.22*	.07	.25*	.60	___

**significant at the 0.01 level (one-tailed)
*significant at the 0.05 level (one-tailed)

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Table 8. TV viewing is not related to central adiposity among males (N=96), after controlling for fitness

	1	2	3	4	5	6
1. Central Adiposity	___					
2. Waist-to-height ratio	.78**	___				
3. Whole Body % Adiposity	.91**	.73**	___			
4. Body Mass Index	.80**	.78**	.68**	___		
5. Television/weekday	.07	-.04	-.02	.12	___	
6. Television/weekend day	.13	-.01	.10	.22	.60	___

**significant at the 0.01 level (one-tailed)
*significant at the 0.05 level (one-tailed)

Figure 8. Central adiposity is higher among females who watch more than 2 hours of TV/weekday
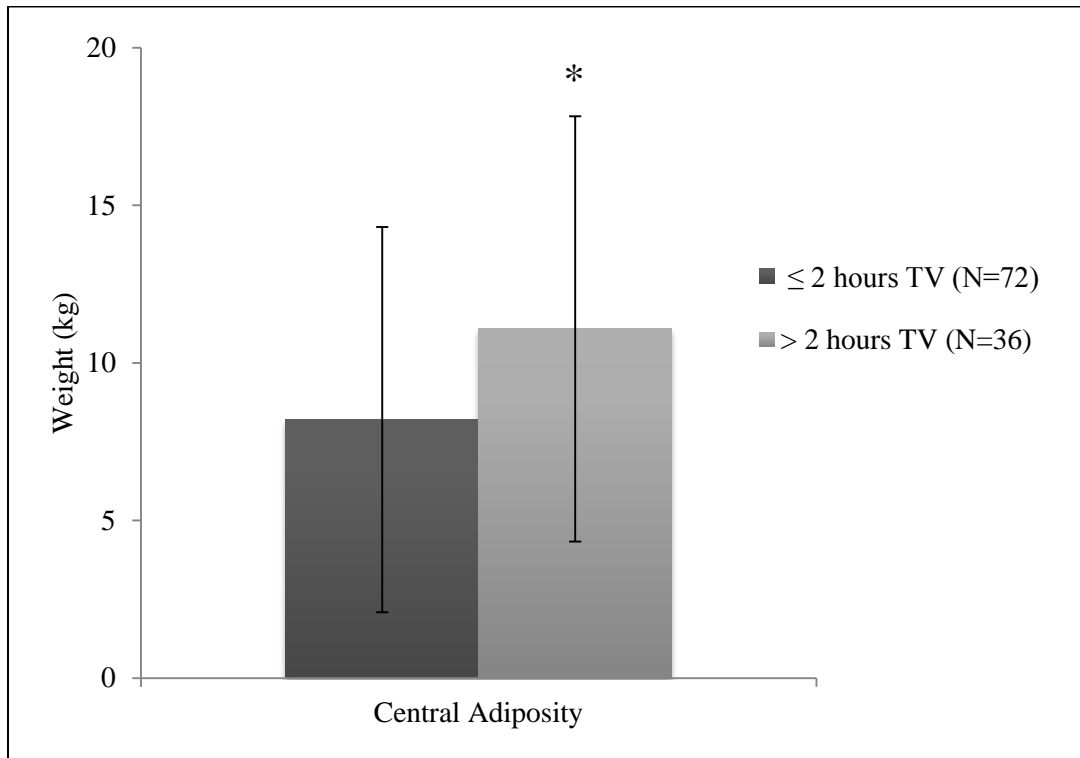
All values presented as Mean ± SD
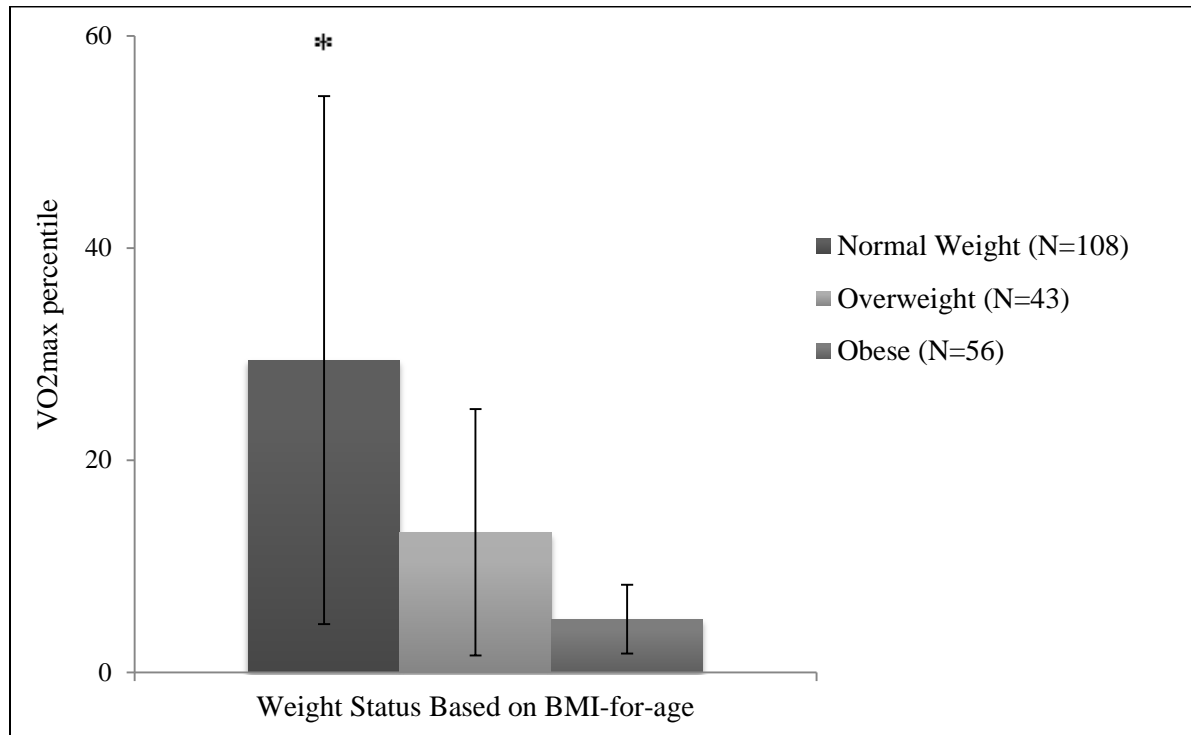* Statistically significant difference between groups (p<0.05) as determined by one-way ANOVA.
Participants separated based on the American Academy of Pediatrics recommendation to limit TV time to less than 2 hours per day (Strasburger, 2011)

Table 9. Diet intake reported by 24-hour recalls among females (N=71)

	Intake Reported	% of Energy	Recommendation
Energy (kcal)	1819 ± 560		1600-1700
Protein (g)	65.8 ± 21.9	14.9	20-30
Fat (g)	66.2 ± 26.4	32.3	25-35
Carbohydrate (g)	243.7 ± 85.4	52.7	45-65
Added Sugars (g)	70.6 ± 45.5	15.5	<25
Saturated Fatty Acids (g)	24.8 ± 11.6	12.2	<10
Cholesterol (mg)	197.6 ± 127.3		<300
Fiber (g)	13.6 ± 6.2		26
Sodium (mg)	2928 ± 1079		<1500
Potassium (mg)	2018 ± 700		4500mg
Calcium (mg)	948.3 ± 438.4		1300

All values presented as Mean ± SD
NDSR (2010) was used for all diet recall analyses

Table 10. Diet intake reported by 24-hour recalls among males (N=81)

	Intake Reported	**% of Energy**	**Recommendation**
Energy (kcal)	2001 ± 600		1700-1800
Protein	73.5 ± 24.2	15.5	20-30
Fat	71.8 ± 24.7	33.0	25-35
Carbohydrate	258.3 ± 85.3	51.5	45-65
Added Sugars	71.2 ± 42.7	14.2	<25
Saturated Fatty Acids	27.1 ± 12.3	12.2	<10
Cholesterol (mg)	211.2 ± 126.8		<300
Fiber (g)	14.4 ± 6.5		31
Sodium (mg)	3404 ± 1281		<1500
Potassium (mg)	2171 ± 863.8		4500mg
Calcium (mg)	1057 ± 502.4		1300

All values presented as Mean ± SD
NDSR (2010) was used for all diet recall analyses

Table 11. No difference in intake reported by 24-hour recall and 3-day food records (N=26)

	Mean	P
Energy (kcal)	1928.19 ± 457.61 (recall)	0.28
	1798.18 ± 372.84 (record)	
Calories from Protein (%)	14.76 ± 2.94	0.42
	15.29 ± 2.22	
Calories from Fat (%)	32.93 ± 7.94	0.24
	34.78 ± 5.64	
Calories from Carbohydrate (%)	52.18 ± 8.57	0.23
	49.94 ± 6.67	
Cholesterol-Saturated Fatty Acid Index	36.40 ± 16.56	0.84
	37.10 ±1.46	

All values presented as Mean ± SD
Differences between recalls and records were assessed using paired samples t-test
NDSR (2010) was used for all diet recall analyses

Figure 9. Females and males have similar macronutrient intake
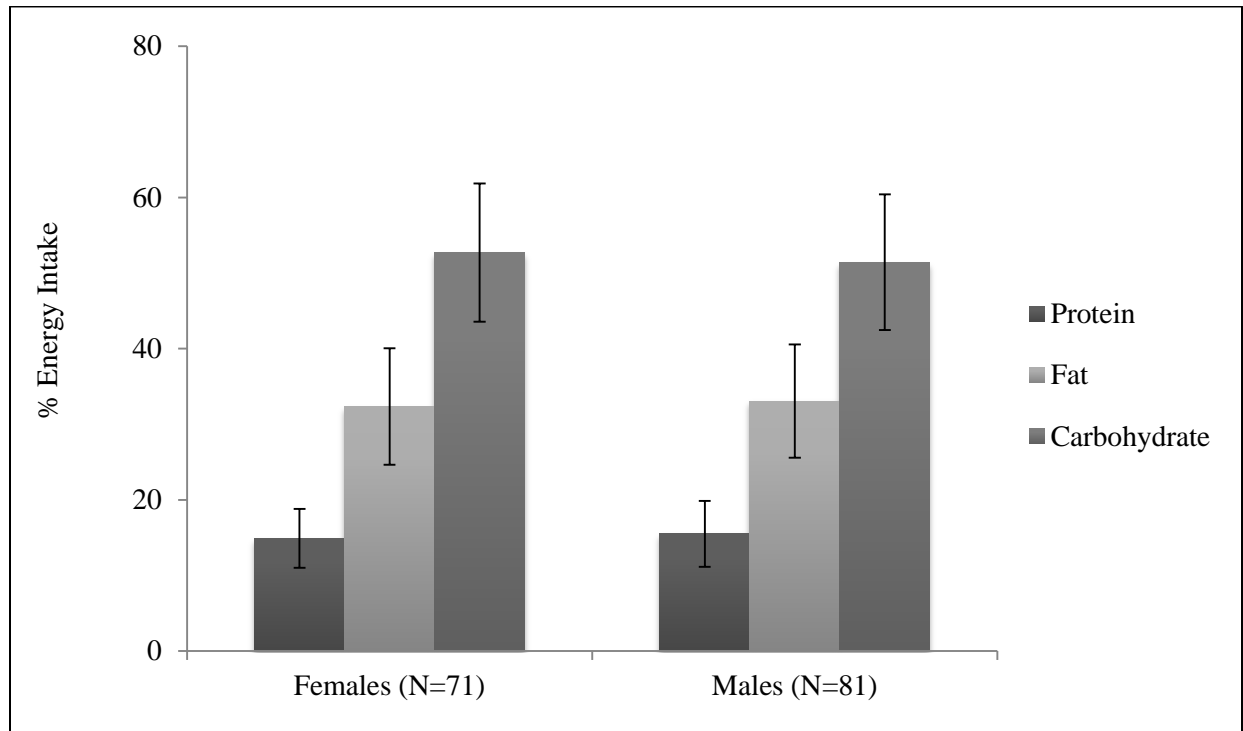
All values presented as Mean ± SD
Differences in groups assessed by one-way ANOVA

Figure 10. Overweight females have higher energy intake than normal weight females
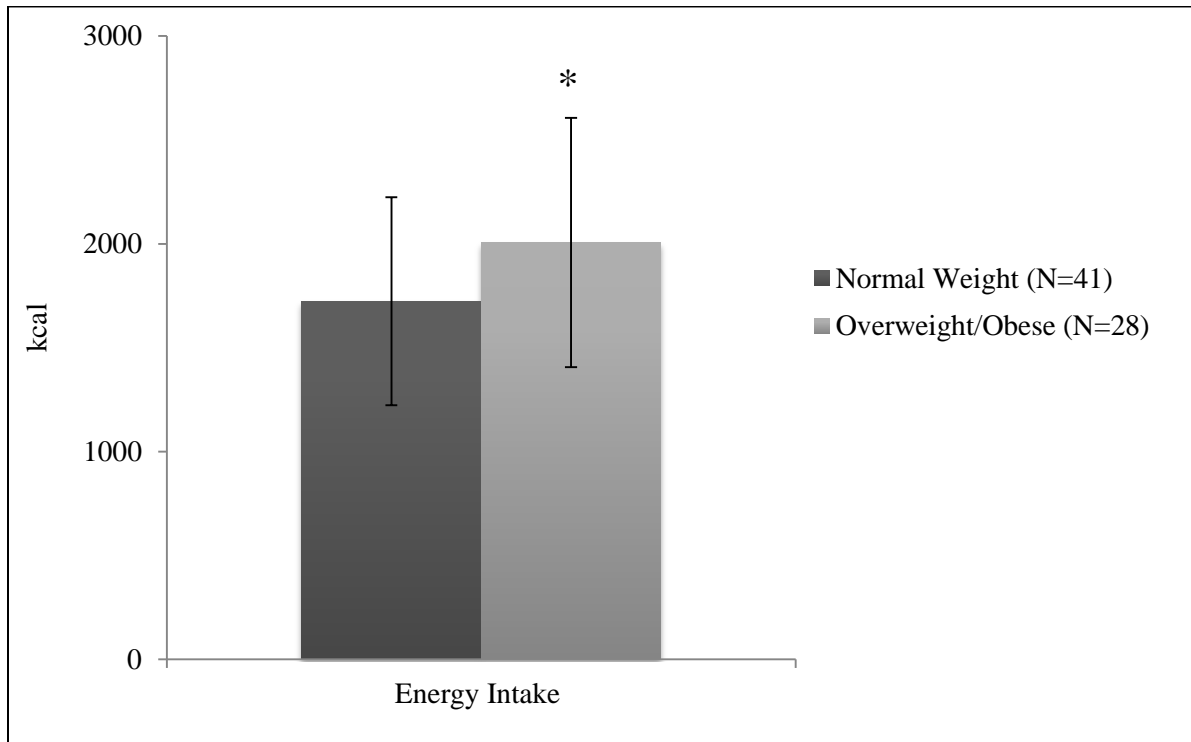
All values presented as Mean ± SD
* Statistically significant difference between groups (p<0.05) as determined by one-way ANOVA.
Participants were categorized using the Centers for Disease Control and Prevention growth charts
(Kuczmarski et al., 2000).

Figure 11. No differences in energy intake between normal weight and overweight males
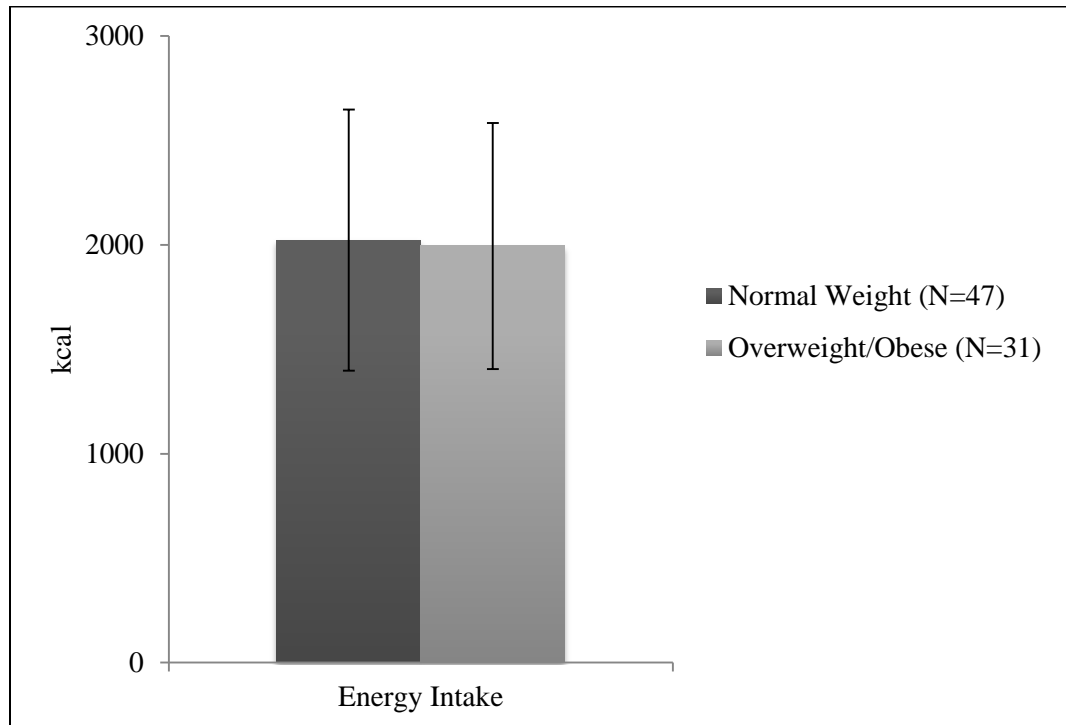
All values presented as Mean ± SD
* Statistically significant difference between groups (p<0.05) as determined by one-way ANOVA.
Participants were categorized using the Centers for Disease Control and Prevention growth charts
(Kuczmarski et al., 2000).

Figure 12. Females above the waist circumference-for-age cutoff consume a diet with a higher cholesterol-saturated fatty acid index[1]
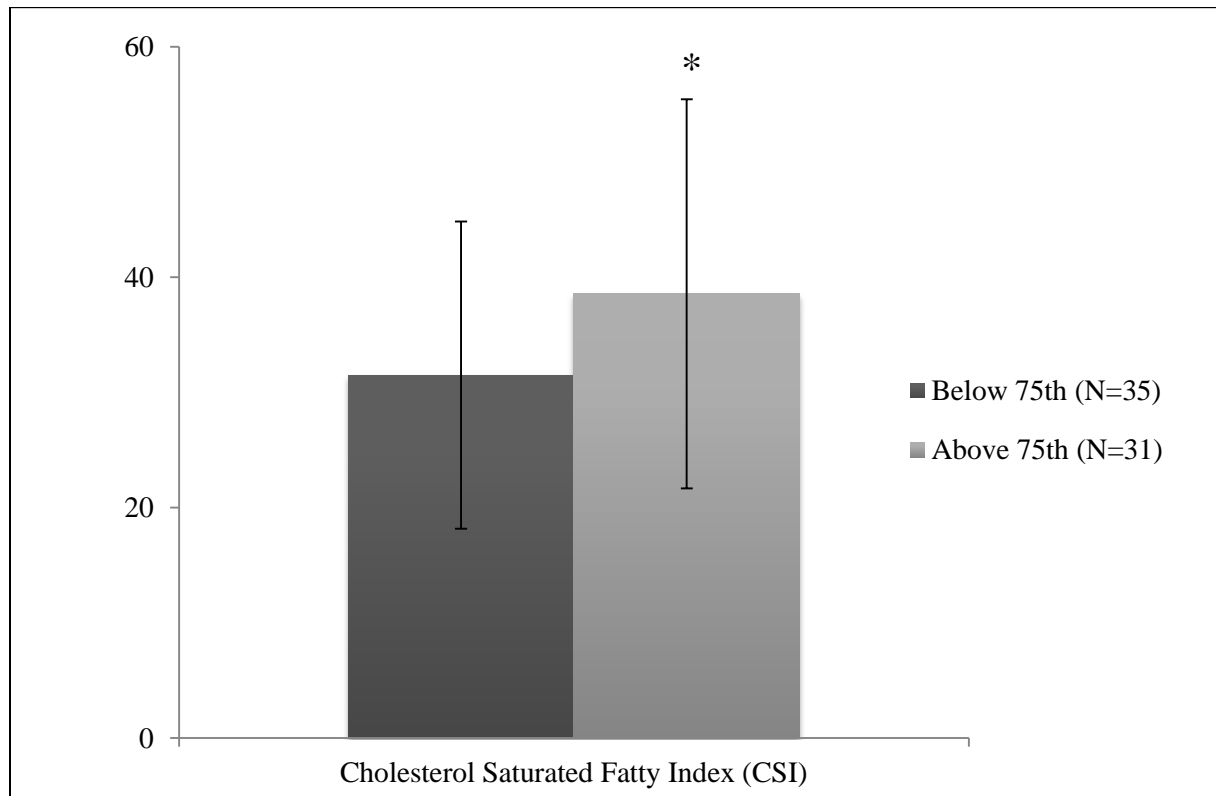
All values presented as Mean ± SD
* Statistically significant difference between groups ($p < 0.05$) as determined by one-way ANOVA.
[1]Cholesterol-saturated fatty acid index (CSI) = 1.01 (g SFA) + .05 (mg Cholesterol)
Participants were categorized using waist circumference-for-age percentile references provided by Fernandez et al. (2004)

Figure 13. Females above the waist circumference-for-age cutoff consume higher added sugars[1]
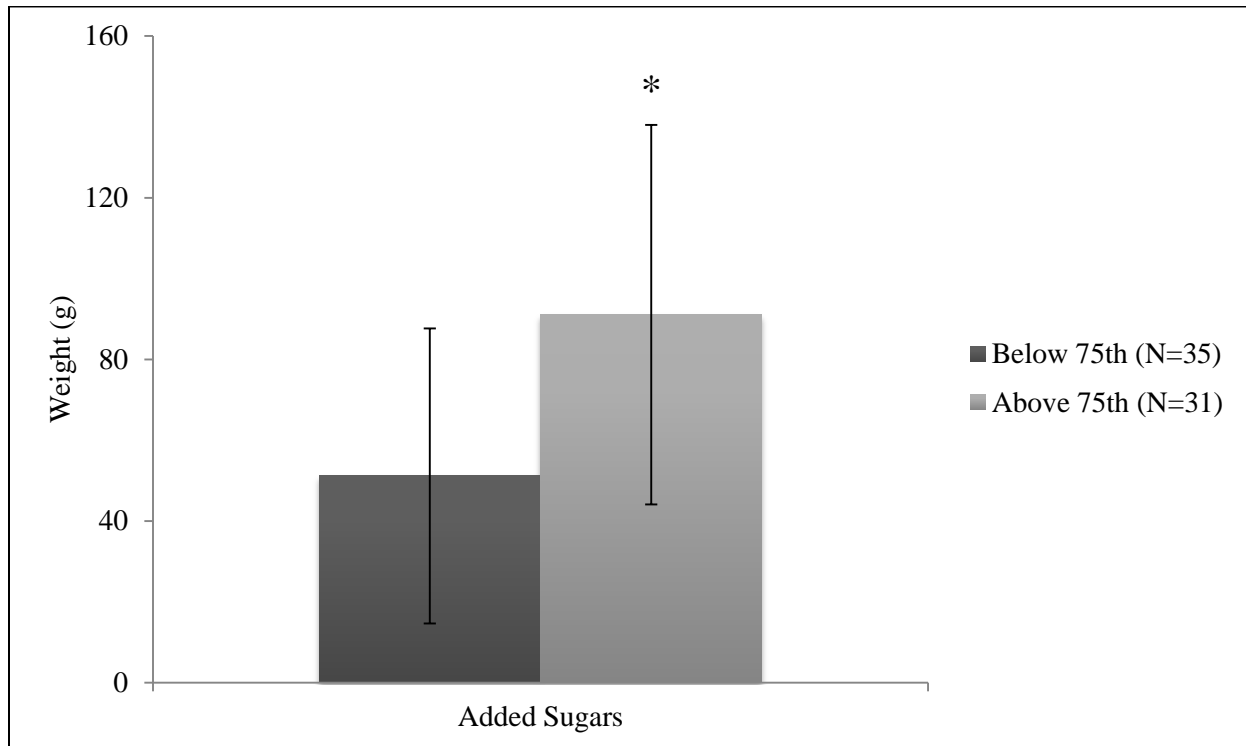
All values presented as Mean ± SD
* Statistically significant difference between groups ($p<0.05$) as determined by one-way ANOVA.
Participants were categorized using waist circumference-for-age percentile references provided by
Fernandez et al. (2004)
[1]Foods classified as added sugars by NDSR (2010) include: white sugar (sucrose), brown sugar,
powdered sugar, honey, molasses, pancake syrup, corn syrups, high fructose corn syrups, invert sugar,
invert syrup, malt extract, malt syrup, fructose, glucose (dextrose), galactose, and lactose.

Table 12. Cholesterol-Saturated Fatty Index related to increased central adiposity among females (N=66), after controlling for fitness and energy intake

	1	2	3	4	5	6
1. Central Adiposity	___					
2. Whole Body %Adiposity	.87**	___				
3. Added Sugars	.11	-.03	___			
4. Cholesterol	.22*	.17	-.16	___		
5. Saturated Fatty Acids	.18	.13	.13*	.20*	___	
6. Cholesterol-Saturated Fatty Acid Index	.26*	.19	.01	.68**	.85**	___

**significant at the 0.01 level (one-tailed)
*significant at the 0.05 level (one-tailed)

Table 13. Cholesterol-Saturated Fatty Index not related to central adiposity among males (N=75), after controlling for fitness and energy intake

	1	2	3	4	5	6
1. Central Adiposity	___					
2. Whole Body %Adiposity	.92**	___				
3. Added Sugars	-.02	-.03	___			
4. Cholesterol	.12	.11	-.14	___		
5. Saturated Fatty Acids	.06	.10	-.25*	.37**	___	
6. Cholesterol Saturated Fat Index	.10	.12	-.25*	.72*	.92*	___

**significant at the 0.01 level (one-tailed)
*significant at the 0.05 level (one-tailed)

Table 14. Reliability analysis of nutrition beliefs questionnaire

Apple vs. Fat-free fruit snack vs. Regular fruit snack

Cottage cheese vs. Fat-free ice cream vs. Regular ice cream

Baked sweet potato vs. Baked potato chips vs. Potato fries

Baked chicken nuggets vs. Deli sliced chicken vs. Fried chicken nuggets

Cronbach alpha = .63

Table 15. Reliability analysis of diet vs. high-energy/low-nutrient subscale

Fat-free cookie or regular cookie

Regular coke or Diet coke

Fat-free- fruit snack or Regular fruit snack

Regular ice cream or Fat-free ice cream

Cronbach alpha = .86

The diet vs. high-energy/low-nutrient subscale was determined by conducting exploratory factor analysis. Two items were removed to achieve the highest possible internal consistency.

Table 16. Nutrition Belief Score related to increased vitamin D, calcium, and reduced calories from fat among females (N=40)

	1	2	3	4	5	6	7	8
1. Total Nutrition Belief Score	___							
2. Diet vs. high-energy/low-nutrient Subscale	.55[**]	___						
3. Vitamin D	.37[*]	.27[*]	___					
4. Total Fat	-.01	.15	-.06	___				
5. Total Saturated Fatty acids	.21	.23	-.05	.83[**]	___			
6. %Calories from Fat	-.31[*]	.06	-.28[*]	.61[**]	.41[**]	___		
7. %Calories from Saturated Fatty Acids	.18	.18	-.12	.51[**]	.81[**]	.57[**]	___	
8. Calcium	.42[**]	.20	.75[**]	.24	.30[*]	-.11	.23	___

**significant at the 0.01 level (one-tailed)
*significant at the 0.05 level (one-tailed)

Table 17. Diet vs. high-energy/low-nutrient subscale related to decreased intake of calories from total and saturated fat among males (N=39)

	1	2	3	4	5	6	7	8
1. Total Nutrition Beliefs Score	___							
2. Diet vs. high-energy/low-nutrient	.66**	___						
3. Vitamin D	-.09	-.11	___					
4. Total Fat	-.19	-.28*	.45**	___				
5. Total Saturated Fatty acids	-.08	-.22	.54**	.83**	___			
6. %Calories from Fat	-.13	-.35*	-.04	.42**	.35*	___		
7. %Calories from Saturated Fatty Acids	-.08	-.30*	.30*	.32*	.66**	.67**	___	
8. Calcium	-.08	-.07	.76**	.53**	.56**	.03	.30*	___

**significant at the .01 level (one-tailed)
*significant at the .05 level (one-tailed)

Table 18. Predictors of central adiposity among females

	β	P	Model R^2
Model 1: Pubertal staging	.482	.00	.225
Model 2: Pubertal staging	.468	.00	.220
Age	.047	.60	
Model 3: Pubertal staging	.319	.00	.443
Age	.060	.432	
Fitness	-.495	.00	
Model 4: Pubertal staging	.409	.00	.501
Age	.106	.262	
Fitness	-.402	.00	
Energy	.097	.297	
Model 5: Pubertal staging	.415	.00	.502
Age	.089	.365	
Fitness	-.408	.00	
Energy	.861	.393	
Added Sugars	-.018	.895	
Model 6: Pubertal staging	.418	.00	.533
Age	.050	.613	
Fitness	-.405	.00	
Energy	-.057	.727	
Added Sugars	-.018	.895	
CSI	.249	.056	

Table 19. Predictors of central adiposity among males

	β	P	Model R^2
Model 1: Pubertal staging	-.044	.652	.002
Model 2: Pubertal staging	-.092	.339	.073
Age	.271	.005	
Model 3: Pubertal staging	-.080	.348	.276
Age	.228	.009	
Fitness	-.453	.00	
Model 4: Pubertal staging	-.062	.538	.279
Age	.310	.003	
Fitness	-.413	.00	
Energy	.034	.734	
Model 5: Pubertal staging	-.064	.528	.279
Age	.304	.004	
Fitness	-.415	.00	
Energy	.038	.740	
Added Sugars	.001	.996	
Model 6: Pubertal staging	-.052	.623	.281
Age	.306	.005	
Fitness	-.418	.00	
Energy	-.009	.957	
Added Sugars	.004	.977	
CSI	.074	.601	

Table 20. Predictors of waist-to-height ratio among females

	β	P	Model R^2
Model 1: Pubertal staging	.459	.00	.211
Model 2: Pubertal staging	.482	.00	.216
Age	-.080	.385	
Model 3: Pubertal staging	.363	.00	.361
Age	-.069	.404	
Fitness	-.397	.00	
Model 4: Pubertal staging	.459	.00	.449
Age	-.099	.320	
Fitness	-.315	.002	
Energy	.156	.113	
Model 5: Pubertal staging	.477	.00	.478
Age	-.142	.159	
Fitness	-.323	.002	
Energy	.140	.311	
Added Sugars	.036	.800	
Model 6: Pubertal staging	.480	.00	.531
Age	-.183	.069	
Fitness	-.320	.001	
Energy	-.064	.694	
Added Sugars	.031	.822	
CSI	.312	.018	

Table 21. Predictors of waist-to-height ratio among males

	β	P	Model R^2
Model 1: Pubertal staging	-.116	.234	.013
Model 2: Pubertal staging	-.136	.169	.026
Age	.114	.248	
Model 3: Pubertal staging	-.126	.170	.167
Age	.078	.395	
Fitness	-.378	.00	
Model 4: Pubertal staging	-.060	.583	.143
Age	.103	.346	
Fitness	-.353	.002	
Energy	.078	.481	
Model 5: Pubertal staging	-.070	.526	.150
Age	.100	.365	
Fitness	-.358	.002	
Energy	.048	.698	
Added Sugars	.082	.501	
Model 6: Pubertal staging	-.118	.302	.167
Age	.137	.230	
Fitness	-.331	.005	
Energy	.022	.897	
Added Sugars	.123	.357	
CSI	-.097	.522	

Table 22. Predictors of whole body % adiposity among females

	β	P	Model R^2
Model 1: Pubertal staging	.365	<.001	.133
Model 2: Pubertal staging	.365	<.001	.133
Age	-.001	.991	
Model 3: Pubertal staging	.200	.018	.406
Age	.013	.871	
Fitness	-.547	<.001	
Model 4: Pubertal staging	.320	.004	.452
Age	.071	.472	
Fitness	-.460	<.001	
Energy	.088	.369	
Model 5: Pubertal staging	.378	<.001	.512
Age	.023	.807	
Fitness	-.447	<.001	
Energy	.150	.118	
Protein (% Energy)	.265	.007	
Model 6: Pubertal staging	.390	.001	.524
Age	.005	.961	
Fitness	-.441	<.001	
Energy	.118	.423	
Protein (%Energy)	.397	.587	
Fat (%Energy)	.396	.768	
CSI	.004	.982	

Table 23. Predictors of whole body % adiposity among males

	β	P	Model R^2
Model 1: Pubertal staging	-.135	.164	.009
Model 2: Pubertal staging	-.174	.072	.067
Age	.223	.022	
Model 3: Pubertal staging	-.161	.054	.313
Age	.176	.036	
Fitness	-.499	<.001	
Model 4: Pubertal staging	-.139	.149	.349
Age	.297	.002	
Fitness	-.474	<.001	
Energy	-.010	.917	
Model 5: Pubertal staging	-.155	.106	.370
Age	.307	.002	
Fitness	-.439	<.001	
Energy	-.051	.607	
Protein (% Energy)	-.154	.125	
Model 6: Pubertal staging	-.157	.116	.388
Age	.335	.001	
Fitness	-.427	<.001	
Energy	-.194	.213	
Protein (%Energy)	-.204	.064	
Fat (%Energy)	-.028	.809	
CSI	.169	.278	

DISCUSSION

Central adiposity has emerged as an important predictor for metabolic complications and adverse health effects (metabolic syndrome, type 2 diabetes, and CVD) among adults and adolescents (Bjrntorp, 1992; Carey et al., 1997). Among adults, the surrogate measure of waist circumference is a critical component of the National Cholesterol Education Program Adult Treatment Panel III and the International Diabetes Federation's criteria for diagnosis of metabolic syndrome (Goran and Gower, 1999; Esmaillzadeh et al., 2006). Although, limited data among children has thus far prevented the establishment of anthropometric cutoffs for abdominal obesity, growing evidence suggests markedly different metabolic profiles can be seen between children above and below the waist circumference-for-age cutoff of 75th percentile (Savva, 2000) and waist-to-height ratio cutoff of 0.5 (Li, 2006). The present study aimed to determine diet and media use factors that are related to increased central adiposity in prepubertal children. Utilization of DXA allowed for assessment of central adiposity as a continuous variable. Additionally, we compared behavioral differences across waist circumference cutoffs that are related to CVD risk factors in children.

Secular trends in activity-related behaviors suggest that 8-18-year-olds spend more time with media (an average of 7.5 hours/day) than any other sedentary activity, besides sleep (Henry J. Kaiser Family Foundation, 2010). Although the use of mobile devices (e.g. cell phones, handheld videogames, mp3 players) has been on the rise, TV viewing is the most widely studied media use variable. Several studies have examined the effects of TV on weight status in children. In a large longitudinal study of 8000 Scottish children, watching more than 8 hours of TV/week at age 3 was related to obesity at age 7 (Reilly, 2005). In another study, each

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additional hour of TV viewing at age 5 increased the risk of being obese in adulthood by 7% (Viner, 2005). Findings from several other studies implicate increased TV viewing in obesity development (Jordan, 2007; Dennison, 2008). However, the present study was unique in three ways: 1) control for cardiorespiratory fitness; 2) control for energy intake; and 3) utilization of direct and anthropometric measures of whole body and regional adiposity. Cardiorespiratory fitness and energy intake have both been independently implicated in development of obesity (Blair, 2004; Rodriguez, 2010)

After controlling for fitness and energy intake, our data showed that weekend TV viewing was related to increased waist-to-height ratio and BMI among females. Furthermore, females who watched more than 2 hours of TV/weekday had significantly higher central adiposity compared to females who watched less than 2 hours of TV/weekday. Among males, weekday TV time was related to increased BMI whereas weekly videogame use and weekend screen-time were related to increased whole body %adiposity. Utilizing whole body measures of adiposity (whole body %adiposity and BMI) as well as fat distribution (central adiposity and waist-to-height- ratio) allowed us to identify which measures were more strongly associated with specific media use components. However, it should be noted that relationships between media use and central adiposity, the primary outcome of this study, were only significant for females and not males. Nevertheless, this was the first study to assess media use among preadolescents and relate it to central adiposity as defined by DXA.

Although some studies have examined the effect of dietary intake in the development of central adiposity, evidence in children remains inadequate. Among adults, higher intake of vegetables, dairy, whole grains and lower intake of processed red meat and soda was related to smaller gains in BMI and waist circumference (Newby et al., 2003). Among a large NHANES

sample of 5-11-year-olds, Bradlee et al. (2009) showed that intakes of dairy and whole grains were inversely related to adiposity. Energy intake and energy from fat have also been shown to be positively related to whole body adiposity (Tucker, 1997). However, the aforementioned studies used surrogate measures of whole body adiposity and fat distribution. To our knowledge, the present study is the first to examine relationships between nutrient intakes and central adiposity measured by DXA among preadolescents. Our finding that added sugars were related to central adiposity may be consistent with previous studies implicating sugar sweetened beverages in childhood obesity (Ludwig, 2001; Berkey, 2004). Additionally, added sugar intake was higher among females who had a waist circumference-for-age above the 75th percentile. However, similar to Berkey et al (2004), the influence of added sugars in our data was attenuated once total energy was controlled for. Although energy intake was related to central adiposity, our results differed from Tucker et al. (1997) since calories from fat were not associated with obesity. Rather, saturated fatty acids and CSI were related to central adiposity even after controlling for fitness and energy intake. These findings may be consistent with Newby et al. (2003) given that processed red meats are often high in cholesterol and saturated fatty acids. However, our diet analyses were limited to the nutrient level and we cannot draw conclusions on food group associations with adiposity. It is noteworthy, however, that we observed differences in diet intake based on waist circumference-for-age cutoffs, similar to findings by Bradlee and colleagues. Future research is needed to further assess the efficacy of using waist circumference cutoffs to assess differences in behavioral factors related to obesity in children.

Several studies among children and teenagers have shown that TV viewing is related to increased intake of energy, fat, and sodas and lower intake of fruits and vegetables (Wechsler, 2003; Wiecha, 2006; Miller, 2008). However, fewer studies have assessed the mediating factors

in the media-diet relationship. In our study nutrition belief scores were inversely related to total screen time and positively related to vitamin D and calcium intake among females. Although the diet vs. high-energy/low-nutrient subscale was not related to screen time, scores among males were inversely related to energy from fats and saturated fats. It appears that nutrition belief scores were influenced by overall media use among females, such that higher scores were associated with dietary intake of nutrients that have known positive associations with healthy growth outcomes in children. These findings suggest that media use may play a role in what foods children think are healthy for them. However, we are unable to implicate any particular medium (e.g. TV or computer use) in nutrition beliefs since we did not assess the specific content that children were viewing. Given that children are exposed to a plethora of food advertisements, majority of which are for foods of low nutritional quality (Gantz, 2007), it is important that future studies examine how media exposure affects children's nutrition beliefs and subsequent diet choices.

Although associations between dieting behaviors and media use have been the subject of research for several years. Recent evidence suggests that dieting behaviors are more prevalent among overweight and obese children compared to their normal weight counterparts (Neumark-Sztainer, 2002). Behaviors such as skipping meals and subsequent binge eating may have the counterproductive effect of weight gain among children attempting to lose weight (Field, 2003; Neumark Sztainer, 2007). In our smallest subgroup of participants, dieting behaviors were related to increased central adiposity, waist-to-height ratio, whole body % adiposity, and BMI. Examining diet data showed that increasing scores on the dieting subscale were related to increased carbohydrate intake and decreased intake of cholesterol. However, the small sample size and inability to separate the groups by gender limits the conclusions that can be drawn from

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these correlations. Nevertheless, future studies are needed to examine the directionality of the obesity-dieting relationship and account for the mediating variables which may include but are not limited to media use.

There is a dearth of information on dietary factors related to central adiposity in prepubertal children. Berkey and coworkers (2004) developed separate models for females and males to predict gains in BMI using different beverages (milk, sugar-sweetened, diet soda, and fruit juices). However, none of the beverages significantly improved the model after adjusting for energy intake. Modeling by Tucker et al. (1997) predicted whole body %adiposity (measured by skinfold thickness) using macronutrient intake, total energy and fiber. Although Tucker and colleagues controlled for fitness, they did not assess effects on fat distribution or central adiposity. Regression models developed from this study are the first in the literature to predict central adiposity using specific nutrients while controlling for the effects of fitness and energy intake. Although pubertal staging and fitness were the main contributors to central adiposity measured by DXA and waist-to-height ratio, dietary variables including energy, added sugars, and CSI explained an additional 10% of the variance among females. The same diet variables explained an additional 17% of the variability of waist-to-height ratio among females. We developed models to predict waist-to-height ratio because it is an anthropometric measure with potential for wide scale application. Waist-to-height ratio also adjusts for participant height and may provide a more clinically relevant outcome compared to a weight measure of central adiposity measured by DXA. Fitness was the strongest predictor of whole body %adiposity followed by pubertal staging. The finding that energy from protein was related to increased whole body %adiposity is consistent with Tucker and co-workers (1997). However, the addition of energy from fat to the model attenuates the effect on energy from protein suggesting

mediating effects of fat intake. Although media use, weekend TV time in particular, appeared to be related to central adiposity, this relationship attenuated after the addition of energy intake to the models. Our data is consistent with other studies that suggest that the media-obesity relationship is mediated by energy intake (Zimmerman, 2010). The lack of relationships between behavioral factors and adiposity in males is worth noting. In a large population-based sample of 9-10-year-olds (N=1700), Jennings and colleagues adjusted for gender, energy density, and physical activity and observed an inverse relationship between overall diet quality scores and BMI Z-score, waist-to-height ratio, and waist circumference. Therefore, it is likely that diet has an influence on anthropometric measures of central adiposity among males as well.

Given that our results displayed a significant contribution of pubertal staging among females and age among males, it is important to understand our findings in the context of typical growth prior to and after the onset of puberty. Early onset of puberty among both males and females has been previously linked to childhood obesity (Davison, 2003; Ahmed, 2009). However, research from the Fels Longitudinal Study suggests that early menarcheal timing (before 11.9 years) is related to greater cardiovascular risk factors (elevated blood pressure and glucose intolerance) independent of body composition (Remsberg, 2005). Rico and colleagues assessed cross-sectional differences in body composition between preadolescents and adolescents using DXA and Tanner stage methodology (Rico, 1993). Stage 4 and 5 children (females and males) had significantly higher fat and fat free mass compared to children in stages 1 and 2. However, females had higher fat mass in stages 4 and 5 compared to males. A similar cross-sectional study showed that females had significantly higher whole body %adiposity than males at all stages of development (Boot et al., 1997). Boot and colleagues also found that, among males, whole body %adiposity was highest in stage 3 with subsequent decreases after the

onset of puberty in stages 4 and 5. Although Tanner staging appeared to be related to body composition in both studies, some key differences are worth noting. Rico et al. (1993) did not observe gender differences in whole body %adiposity at stages 1 and 2 while Boot and coworkers (1997) showed sex differences across all Tanner stages. Furthermore, while Rico et al. (1993) observed increased fat mass between later and earlier stages of development among both genders, Boot and colleagues (1997) found that stage 4 and 5 males had lower fat mass and whole body %adiposity than those in stage 3. Our study results are consistent with those from Boot and colleagues (1997), since we observed significant differences in both total fat mass and whole body %adiposity between females and males in Tanner stages 1 and 2. It appears that studies are consistent in their findings for post pubertal somatic changes in children. However, additional research is needed among prepubertal children since results have been equivocal thus far. Collectively, outcomes from multiple body composition studies suggest that males continue to accrue fat free mass whereas females increase in both fat free and fat mass as they go through puberty. The additional impact of specific diet and activity-related behaviors on excess adiposity during this transitional phase of development needs to be further assessed.

CONCLUSIONS & FUTURE DIRECTIONS

Although growth occurs throughout childhood, preadolescence represents an important transition phase from childhood to adolescence and is characterized by significant body compositional changes (Boot et al., 1997; Maggs et al., 1997). However, preadolescents are an understudied population group and there is limited research on behavioral factors related to excess fat accumulation during this critical period of development. Given its causal link to insulin resistance, it is concerning that much of the childhood obesity literature has failed to assess outcomes related to central adiposity. Therefore, we sought to assess the independent effects of media use and nutrient intake on central adiposity among preadolescent children. Previous studies have varied in their assessment of obesity and behaviors related to energy balance. Our study utilized high quality measures to assess cardiorespiratory fitness and measures of whole body and central adiposity. Furthermore, we assessed the key behavioral factors of diet and media use that have been previously shown to contribute to excess body weight. **Figure 14** illustrates the observed relationships between the main outcomes of our study.

It is important to recognize the role of gender in our findings. Initial body composition analyses revealed that females and males differed across all measures of adiposity, including the primary outcome of central adiposity. Therefore, separate conclusions were drawn based on gender groups. The effects of media use appear to differ by medium and day type. After controlling for fitness, weekend TV and video game use were related to measures of whole body, but not central adiposity. Additionally, weekend TV time appeared to influence energy intake, cholesterol and added sugars, however, these relationships attenuated once energy intake was

controlled for. Our overall media findings suggest that the influence of TV time on central adiposity is not independent and may be mediated by fitness and diet intake among children. Furthermore, the relationship between diet and TV time was independent of total nutrition belief scores. This finding was in contrast to our expectations as suggested in **Figure 1**. However, nutrition beliefs appeared to mediate the interaction between diet and central adiposity. Future research needs to consider non media factors (e.g. parental and peer influencers) on diet intake. Nutrient analyses implicated intake of energy, added sugars, and cholesterol-saturated fatty acid index as an important predictors of central adiposity. After controlling for fitness and energy intake, the influence of these nutrients was non-significant among males. Collectively, these results suggest that dietary and sedentary behaviors may have differential health-related outcomes for prepubertal children based on gender. These findings have implications for nutrition education or intervention efforts that may need to be modified to account for age and pubertal staging when targeting obesity prevention during the critical period of preadolescence.

Limitations

There were several limitations to this study. These results were based on a secondary data analysis and participants were recruited for a physical activity trial and not a body composition study. Therefore, the sample selected may not accurately represent the general population of preadolescents. The use of a single day's dietary recall may limit the precision of estimated dietary intakes of individuals. Additionally, there is the possibility that children may have underreported their dietary intake. As with any cross-sectional analysis, cause and effect cannot be determined and assumptions were made regarding directionality of relationships.

Although our study was limited by its cross-sectional design, we were able to draw important behavioral and development associations with central adiposity for future research. Longitudinal studies are needed to assess changes in central adiposity vs. whole body adiposity during the transitional phase from preadolescence to adolescence.   Given that nutrients are scarcely consumed in isolation, the influence of food groups and diet patterns on central adiposity needs to be determined.   Although we found significant associations between nutrition beliefs and diet intake, the moderate internal consistency of the questionnaire suggests need for modification and further testing. Finally, studies with different dietary and sedentary activity intervention targets for preadolescent females and males will greatly improve our understanding of obesity in this age group.
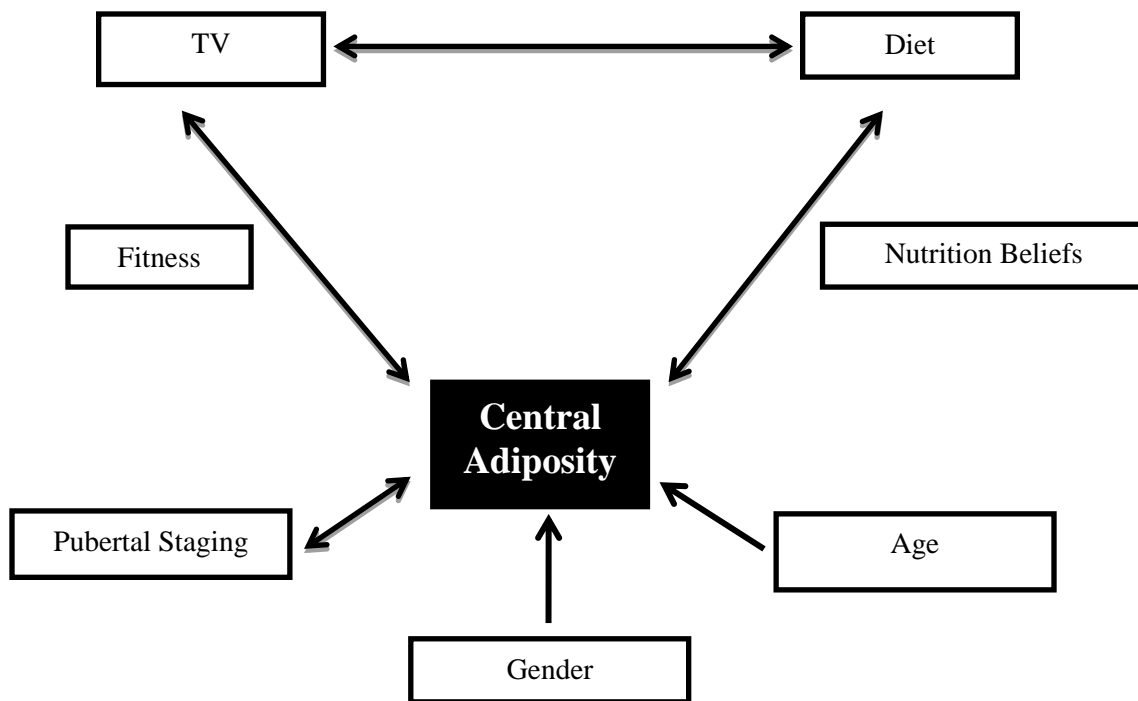
Figure 14. Summary of findings demonstrating interactions between media, diet, and central adiposity

APPENDIX A

PARTICIPANT DEMOGRAPHICS QUESTIONNAIRE

General Information

1. What was your child's date of birth? _____/_____/_____

2. Was your child born before 38 weeks of pregnancy?   □ Yes □ No

   If yes, how early was your child born? _____

3. What was your child's birth weight? _____lbs _____oz

4. Did the mother of your child suffer from any medical condition while she was pregnant?   □ Yes □ No   If yes, what condition?

5. What is your child's current age? _____

6. What is your child's current (or recently completed) Grade Level? _____

7. What is your child's sex?   □ Male   □ Female

8. Which is your child's dominant hand?   □ Right   □ Left   □No Preference

9. Is your child color blind?   □ Yes □ No

10. Does your child wear contacts or glasses?   □ Yes □ No

    If yes, what was their prescription for?

Demographics

1. Does your child live with their biological parents?   □ Yes □ No

2. Does your child live in a single parent/guardian household?   □ Yes □ No

3. Does your child live with their Mother or a Female guardian?   □ Yes □ No

4. Does your child's Mother/Female guardian work?   □ Yes □ No

5. What is the highest level of education obtained by your child's Mother/Female guardian?

       a) Did not complete high school   d) Bachelor Degree

       b) High School Graduate   e) Advanced Degree

       c) Some College

6. Does your child live with their Father or a Male guardian?   □ Yes □ No

7. Does your child's Father/Male guardian work?   □ Yes □ No

8. What is the highest level of education obtained by your child's Father/Male guardian?

       a) Did not complete high school   d) Bachelor Degree

       b) High School Graduate   e) Advanced Degree

       c) Some College

9. How many other children (under the age of 18) live with your child? _____

     How old are they? _____

     What is their sex? _____

10. How many biological siblings does your child have? _____

11. Does your child receive free or reduced-price school lunch?   □ Yes   □ No

12. Do you consider yourself to be Hispanic or Latino (*A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race*)?

    □ Yes   □ No

13. What race / ethnicity do you consider your child?

    a) American Indian or Alaska Native   d) Native Hawaiian or other Pacific Islander

    b) Asian   e) White or Caucasian

    c) Black or African American   f) Mixed or Other

14. What is your approximate household income?

    a) <10,000   g) 61,000-70,000

    b) 10,000-20,000   h) 71,000-80,000

    c) 21,000-30,000   i) 81,000-90,000

    d) 31,000-40,000   j) 91,000-100,000

    e) 41,000-50,000   k) 100,000+

    f) 51,000-60,000

Activities

1. Does your child participate in musical activities?   □ Yes □ No

    If yes:

    Does your child play an instrument?   □ Yes □ No

      If so, what instrument(s)?

    Does your child participate in choir?   □ Yes □ No

    How many hours a week does your child spend participating in musical activities?

2. Does your child participate in religious activities?   □ Yes □ No

    If yes, how many hours a week does your child spend participating in religious activities?

3. Does your child participate in sports activities?   □ Yes □ No

    If yes:

    Does your child participate in formal youth sports?   □ Yes □ No

In what activities does your child participate?

4. Has your child attended regular afterschool care outside of your home in the last year?

   □ Yes   □ No

Habits

1. How much time does your child spend watching <u>television</u> on an average day during the <u>week</u>?

a) < 1 Hour per Day	f) 5 to 6 Hours per Day
b) 1 to 2 Hours per Day	g) 6 to 7 Hours per Day
c) 2 to 3 Hours per Day	h) 7 to 8 Hours per day
d) 3 to 4 Hours per Day	i) > 8 Hours per Day
e) 4 to 5 Hours per Day	

2. How much time does your child spend watching <u>television</u> on an average day during the <u>weekend</u>?

a) < 1 Hour per Day	f) 5 to 6 Hours per Day
b) 1 to 2 Hours per Day	g) 6 to 7 Hours per Day
c) 2 to 3 Hours per Day	h) 7 to 8 Hours per day
d) 3 to 4 Hours per Day	i) > 8 Hours per Day
e) 4 to 5 Hours per Day	

3. How much time does your child spend on a <u>computer</u> on an average day during the <u>week</u>?

a) < 1 Hour per Day	f) 5 to 6 Hours per Day
b) 1 to 2 Hours per Day	g) 6 to 7 Hours per Day
c) 2 to 3 Hours per Day	h) 7 to 8 Hours per day
d) 3 to 4 Hours per Day	i) > 8 Hours per Day
e) 4 to 5 Hours per Day	

4. How much time does your child spend on a <u>computer</u> on an average day during the <u>weekend</u>?

a) < 1 Hour per Day	f) 5 to 6 Hours per Day
b) 1 to 2 Hours per Day	g) 6 to 7 Hours per Day
c) 2 to 3 Hours per Day	h) 7 to 8 Hours per day
d) 3 to 4 Hours per Day	i) > 8 Hours per Day
e) 4 to 5 Hours per Day	

5. How much time does your child spend playing <u>video games</u> on an average during the <u>week</u>?

      a) < 1 Hour per Day   f) 5 to 6 Hours per Day

      b) 1 to 2 Hours per Day   g) 6 to 7 Hours per Day

      c) 2 to 3 Hours per Day   h) 7 to 8 Hours per day

      d) 3 to 4 Hours per Day   i) > 8 Hours per Day

      e) 4 to 5 Hours per Day

6. How much time does your child spend playing <u>video games</u> on an average during the <u>weekend</u>?

      a) < 1 Hour per Day   f) 5 to 6 Hours per Day

      b) 1 to 2 Hours per Day   g) 6 to 7 Hours per Day

      c) 2 to 3 Hours per Day   h) 7 to 8 Hours per day

      d) 3 to 4 Hours per Day   i) > 8 Hours per Day

      e) 4 to 5 Hours per Day

7. How much time does your child spend being <u>physically active</u> on an average during the <u>week</u>?

      a) < 1 Hour per Day   f) 5 to 6 Hours per Day

      b) 1 to 2 Hours per Day   g) 6 to 7 Hours per Day

      c) 2 to 3 Hours per Day   h) 7 to 8 Hours per day

      d) 3 to 4 Hours per Day   i) > 8 Hours per Day

      e) 4 to 5 Hours per Day

8. How does your child travel to school?

      a. Walking

      b. Bicycle

      c. Public Transport

      d. Bus

      e. Car

9. How much time does your child spend being <u>physically active</u> on an average during the <u>weekend</u>?

      a) < 1 Hour per Day   f) 5 to 6 Hours per Day

      b) 1 to 2 Hours per Day   g) 6 to 7 Hours per Day

      c) 2 to 3 Hours per Day   h) 7 to 8 Hours per day

      d) 3 to 4 Hours per Day   i) > 8 Hours per Day

      e) 4 to 5 Hours per Day

10. How much sleep does your child regularly get?

        a) < 5 Hours per Day   e) 8 to 9 Hours per Day

        b) 5 to 6 Hours per Day   f) 9 to 10 Hours per Day

        c) 6 to 7 Hours per Day   g) > 10 Hours per Day

        d) 7 to 8 Hours per Day

11. How much sleep did your child get last night?

        a) < 5 Hours   e) 8 to 9 Hours

        b) 5 to 6 Hours   f) 9 to 10 Hours

        c) 6 to 7 Hours   g) > 10 Hours

        d) 7 to 8 Hours

12. Does your child have any of the following in his/her bedroom

        a. TV

        b. Computer

        c. Gaming console

13. How many caffeinated soft drinks does your child regularly drink in a day?

       □ None   □ One   □ Two   □ Three or more

14. How many cups of tea does your child regularly drink in a day?

       □ None   □ One   □ Two   □ Three or more

15. How often would you rate your child's stress level as HIGH?

       □ Occasionally   □ Frequently   □ Constantly

When was the last time your child:

        Had a caffeinated substance?

        Ate a meal or a snack?

        What did s/he have to eat?

        Exercised?

        What type of exercise?

        How long did s/he exercise for?

        How intense did s/he work-out?

General Health

    1. When was the last time your child saw a doctor?   _____

    2. Does your child have any allergies?   □ Yes □ No

    3. Has your child ever been diagnosed with dyslexia?   □ Yes □ No

4. Has your child ever been diagnosed with an attentional disorder?   □ Yes □ No

5. Has your child ever been diagnosed with asthma?   □ Yes □ No

6. Is your child epileptic?   □ Yes □ No

7. Is your child diabetic?   □ Yes □ No

      If so please explain:

8. Has your child been diagnosed with any kind of cancer?   □ Yes □ No

      If so please explain:

9. Does your child have hearing loss or wear a hearing aid?   □ Yes □ No

10. Has your child been hospitalized within the last 6 months?   □ Yes □ No

      If so please explain:

11. Has your child ever lost consciousness as a result of hitting their head?   □ Yes □ No

      If yes:

      When did this occur?

      Where did s/he hit his/her head?

      How long was s/he unconscious?

12. Has your child ever lost consciousness as a result of any other type of injury or seizure?

  □ Yes   □ No

      If yes:

      When did this occur?

      How long was s/he unconscious?

Medications/Supplements

Medications: Is your child presently taking or have they taken any of the following medications within the past two months? Please circle your answer.

Asprin, Bufferin, Anacin	Tranquilizers
Blood Pressure pills	Weight reducing pills
Cortisone	Blood thinning pills
Cough Medicine	Dilantin
Digitalis	Allergy Shots
Hormones	Water pills
Insulin or Diabetic pills	Antibiotics

Iron or poor blood medications	Barbiturates	
Laxatives	Phenobarbital	
Sleeping pills	Thyroid medicine	

Other(s):_____

1. Does your child take Ginkgo Biloba supplements?   □ Yes □ No

   If yes:

   When was the last time they took the supplement?

   What dose of the supplement did they take?

2. Does your child take Iron supplements?   □ Yes □ No

   If yes:

   When was the last time they took the supplement?

   What dose of the supplement did they take?

3. Does your child take any stimulants or sedatives?   □ Yes □ No

   If yes:

   What do they take?

   When was the last time they took it?

   What dose of it did they take?

Cardiovascular Health

Does your child have any of the following:

1. □ Yes □ No   Pain or discomfort in the chest, neck, jaw, arms, or other areas that may be related to poor circulation.
2. □ Yes □ No   Heartbeats or palpitations that feel more frequent or forceful than usual or feeling that your heart is beating very rapidly.
3. □ Yes □ No   Unusual dizziness or fainting.
4. □ Yes □ No   Shortness of breath while lying flat or a sudden difficulty in breathing that wakes them up while sleeping.
5. □ Yes □ No   Shortness of breath at rest or with mild exertion (such as walking two blocks).
6. □ Yes □ No   Feeling lame or pain in the legs brought on by walking.
7. □ Yes □ No   A known heart murmur.

8. □ Yes □ No   Unusual fatigue with usual activities.

9. □ Yes □ No   Has any male in your immediate family had a heart attack or sudden death before the age of 55?

10. □ Yes □ No   Has any female in your immediate family had a heart attack or sudden death before the age of 65?

11. □ Yes □ No   Do you have family history of heart disease?

12. □ Yes □ No   Do you have family history of lung disease?

13. □ Yes □ No   Do you have family history of diabetes?

14. □ Yes □ No   Do you have family history of strokes?

15. □ Yes □ No   Has your child been diagnosed with a past or present cardiovascular disease?

16. □ Yes □ No   Does your child have any significant heart rhythm disorder?

17. □ Yes □ No   Has your child been diagnosed with hypertension?

18. □ Yes □ No   Has your child been diagnosed with peripheral vascular disease?

Other

Is there anything else you feel we should know about your child's current/past health?

TWO-DAY MEDIA LOG

PLEASE FILL OUT THIS DIARY FOR ONE WEEKDAY AND ONE WEEKEND DAY

This diary will record your activity for two days (one weekday and one weekend day). Each section in the diary contains an Activities Grid and one end of day question. Please fill in the Activities Grid throughout the day. At the end of the day, before you go to sleep, please answer the question at the end of the section and make sure the Activities Grid is complete.

START DATE:
Before you begin to use the Activities Grid, please fill in the date you are beginning your diary on the next page.

ACTIVITIES GRID:
The Activities Grid is designed to help you keep track of the different kinds of media you have used through out the day. Each column is for a different half hour period of the day. There are three different questions.

1. **WERE YOU DOING ANY MEDIA ACTIVITIES FOR AT LEAST 15 MINUTES?**
   (CIRCLE "YES" OR "NO". PLEASE DO NOT LEAVE BLANK)
   YES – Answer the questions below.
   NO – Go to the next time slot.

2. **WHAT WAS YOUR MAIN MEDIA ACTIVITY?** *(CIRCLE ONLY*

1. Listening to music	7. Playing computer games
2. Watching TV	8. Doing homework on computer
3. Watching Videotapes/DVDs	9. Instant messaging
4. Watching a movie (in theater)	10. Emailing
5. Reading for fun (books, magazines, etc)	11. Visiting websites
6. Playing video games (handheld or player)	12. Other computer activities

 ONE ANSWER)
Please circle the number that matches the one media activity that you were paying most attention to. Then answer the next question about the media activity you circled.

3. **WHAT ELSE WERE YOU DOING?** *(CIRCLE AS MANY ANSWERS AS YOU NEED)*

1. Nothing else	9. Reading
2. Chores	10. Playing video games
3. Eating	11. Playing computer games
4. Talking on the phone	12. Instant messaging
5. Homework (not on computer)	13. Emailing
6. Homework (on computer)	14. Visiting websites
7. Listening to music	15. Other computer activities
8. Watching TV, videos, or DVDs	16. Something else (write in activity: _____)

Please circle the number or numbers that match the other things you were doing when you were reading, listening to music, playing a videogame, watching TV or a movie, or using the computer. If you were doing "Something else", please write in your answer.

4. **WHERE WERE YOU?** *(CIRCLE ONLY ONE ANSWER)*

1. My bedroom	5. Before/after school
2. Another room at home	6. Car or bus or train
3. A friend's home	7. Someplace else
4. School	

Please circle the number that matches the place where you were when you were doing this activity.

5. **WHO WAS WITH YOU?** *(CIRCLE AS MANY ANSWERS AS YOU NEED)*

1. I was mainly home	5. Sitter or nanny
2. Mother or father	6. Grandparent
3. Brother or sister	7. Teacher
4. Friend	8. Someone else

Please circle the number or numbers that match the people that were with you when you were doing the activity.

THANK YOU FOR HELPING US WITH THIS IMPORTANT PROJECT!

PLEASE RETURN THIS DIARY TO A FITKIDS STAFF MEMBER

DAY ONE

	6:00-6:30AM	6:30-7:00AM	7:00-7:30AM	7:30-8:00AM	8:00-8:30AM	8:30-9:00AM
1. WERE YOU DOING ANY MEDIA ACTIVITIES FOR AT LEAST 15 MINUTES? (see activities list in question 2)	*CIRCLE ONLY ONE ASWER – PLEASE DO NOT LEAVE BLANK*					
YES – Answer the questions below. NO – Go to the next time slot.	YES No Answer questions below ↓	YES No Answer questions below ↓	YES No Answer questions below ↓	YES No Answer questions below ↓	YES No Answer questions below ↓	YES No Answer questions below ↓
2. WHAT WAS YOUR MAIN MEDIA ACTIVITY?	*CIRCLE ONLY ONE ASWER*					
1. Listening to music 2. Watching TV 3. Watching Videotapes/DVDs 4. Watching a movie (in theater) 5. Reading for fun (books, magazines, etc) 6. Playing video games (handheld or player)	7. Playing computer games 8. Doing homework on computer 9. Instant messaging 10. Emailing 11. Visiting websites 12. Other computer activities	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
3. WHAT ELSE WERE YOU DOING?	*CIRCLE AS MANY ANSWERS AS YOU NEED*					
1. Nothing else 2. Chores 3. Eating 4. Talking on the phone 5. Homework (not on computer) 6. Homework (on computer) 7. Listening to music 8. Watching TV, videos, or DVDs	9. Reading 10. Playing video games 11. Playing computer games 12. instant messaging 13. Emailing 14. Visiting websites 15. Other computer activities 16. Something else (write in activity: _____	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
4. WHERE WERE YOU?	*CIRCLE ONLY ONE ASWER*					
1. My bedroom 2. Another room at home 3. A friend's home 4. School	5. Before/after school 6. Car or bus or train 7. Someplace else	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7
5. WHO WAS WITH YOU?	*CIRCLE AS MANY ANSWERS AS YOU NEED*					
1. I was mainly home 2. Mother or father 3. Brother or sister 4. Friend	5. Sitter or nanny 6. Grandparent 7. Teacher 8. Someone else	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8

DAY OF THE WEEK
(CIRCLE ONE ANSWER ONLY)

SUNDAY……………………………..	1
MONDAY………………………………	2
TUESDAY………………………………	3
WEDNESDAY……………………………	4
THURSDAY……………………………	5
FRIDAY………………………………………	6
SATURDAY…………………………..	7

TODAY'S DATE
(WRITE ANSWER BELOW)

_____ _____ _____

MONTH   DAY   YEAR

TODAY, HOW MUCH TIME DID YOU SPEND DOING THE FOLLOWING ACTIVITIES?
(CIRCLE ONE ANSWER NEXT TO EACH STATEMENT – A THROUGH F)

	None	30 minutes or less	1 hour	2 hours	3 hours	4 hours or more
A. Being in school	0	1	2	3	4	5
B. Working at a job	0	1	2	3	4	5
C. Doing chores	0	1	2	3	4	5
D. Doing homework	0	1	2	3	4	5
E. Participating in a sports team, hobby, or club	0	1	2	3	4	5
F. Being in a Child-Care or Before/After School Program	0	1	2	3	4	5

(Henry J. Kaiser Family Foundation, 2010)

APPENDIX C
24-HOUR RECALL

Intake Date: _____

Time	Food/ Beverage	Amount	Brand Name /Preparation	Location	TV/Computer/ Video game

Does this represent your usual intake? _____

If no please state why_____

During the past 7 days, how many times did all, or most, of your family living in your house eat a meal together?

Never   1-2 times   3-4 times   5-6 times   7 times   More than 7 times

3-DAY FOOD RECORD

Instructions for Completing the 3-Day Food Record

1. Record everything your child ate or drank (including supplements) during the 24-hour time period indicated (12:01 a.m. to midnight). Repeat this for a total of 3 days (2 week days, 1 weekend day).
2. To the best of your ability, describe combination or mixed dishes that were eaten. For example, what ingredients were included on that piece of pizza? Was it thick or thin crust? Include brand names if known.
3. Describe the amounts consumed in terms appropriate for that item. For example: ounces (cups) of milk, tablespoons of French dressing, slices of bread, pieces of fruit, etc. If you had a piece of pizza, how big was it in inches or sections, etc.? Record exact amounts to the best of your ability.

Sample Breakfast

Raisin bran cereal	1 cup.
2% milk	6 oz.
Orange	1 medium size, 3" diameter
Toast (whole wheat)	1 slice
with butter	1 teaspoon
with strawberry jam	1 tablespoon
Black coffee	1 cup (8 oz.)
with sugar	2 teaspoons

4. Remember to include beverages, and anything your child may add to them, such as milk or sweetener.
5. Remember to include anything added to a food after it is prepared, such as margarine, salt, catsup, mustard and the estimated amount.
6. If you need additional space, use the back of the paper or attach additional sheets.
7. Answer the question at the bottom of the day's record. (Does this day's record represent your child's usual food intake? ___ Yes ___ No). If your answer is no, explain why it wasn't representative. Was your child ill or was he/she on a special diet? Did you have unexpected guests and you took them out to dinner?
8. If you have any other questions concerning the food diary, please call Naiman at 217-244-2962. Or email Naiman at nakhan2@illinois.edu

Time/ Meal	Food, Beverage, Condiments	Amount Eaten	Brand/Name How prepared	Home /Out

Does this day's record represent your usual days' intake? _____ yes _____ no

If no, explain why not _____

Time/ Meal	Food, Beverage, Condiments	Amount Eaten	Brand/Name How prepared	Home /Out

Does this day's record represent your usual days' intake? _____ yes _____ no

If no, explain why not _____

Time/ Meal	Food, Beverage, Condiments	Amount Eaten	Brand/Name How prepared	Home /Out

Does this day's record represent your usual days' intake? _____ yes _____ no

If no, explain why not _____

1.   Has food intake declined over the past 3 months due to loss of appetite, digestive problems,
      chewing or swallowing difficulties?
      0= severe loss of appetite

      1= moderate loss of appetite

      2= no loss of appetite

           Response: ____

2.   Have you suffered any psychological stress or acute disease in the past 3 months?
      0= yes

      2= no

           Response: ____

NUTRITION BELIEFS QUESTIONNAIRE

Now I'm going to ask you about different foods. Sometimes you hear teachers and parents talking about which foods are good for you and which foods are not. I'm going to ask you which of two foods is better for helping you grow up strong and healthy.

1) Whole wheat bagel or   Fat-free cookie

Reason:
_____
_____

2) Diet Coke   or   2% Milk

Reason:
_____
_____

3) Apple   or   Fat-free fruit snack

Reason:
_____
_____

4) Fat-free ice cream   or   Cottage Cheese

Reason:
_____
_____

5) Baked sweet potato or   Baked potato chips

Reason:
_____
_____

6) Baked chicken nuggets   or   Deli sliced chicken

Reason:
_____
_____

7) Fat-free cookie   or   Regular cookie

Reason:
_____
_____

8)   Regular Coke   or   Diet Coke

Reason:
_____
_____

9)   Fat-free- fruit snack   or   Regular fruit snack

Reason:
_____
_____

10) Regular ice cream   or   Fat-free ice cream

Reason:
_____
_____

11) Baked potato chips or   Potato fries

Reason:
_____
_____

12) Fried chicken nuggets   or   Baked chicken nuggets

Reason:
_____
_____

13) Whole wheat bagel or   Regular cookie

Reason:
_____
_____

14) Regular Coke   or   2% milk

Reason:
_____
_____

15) Apple   or   Regular fruit snack

Reason:
_____
_____

16) Regular ice cream   or   Cottage cheese

Reason:
_____
_____

17) Baked sweet potato   or   Potato fries

Reason:

_____
_____

18) Fried chicken nuggets   or   Deli sliced chicken

Reason:

_____
_____

CHILDREN'S EATING ATTITUDES TEST

These questions ask about your eating habits and attitudes. Please answer as quickly and as honestly as possible by circling/underlining one response for each statement.

1. I am scared about being overweight.

Never   Rarely   Sometimes   Often   Usually   Always

2. I stay away from eating when I am hungry.

Never   Rarely   Sometimes   Often   Usually   Always

3. I think about food a lot of the time.

Never   Rarely   Sometimes   Often   Usually   Always

4. I have gone on eating binges where I feel that I might not be able to stop.

Never   Rarely   Sometimes   Often   Usually   Always

5. I cut my food into small pieces.

Never   Rarely   Sometimes   Often   Usually   Always

6. I am aware of the energy (calorie) content in foods that I eat.

Never   Rarely   Sometimes   Often   Usually   Always

7. I try to stay away from foods such as breads, potatoes, and rice.

Never   Rarely   Sometimes   Often   Usually   Always

8. I feel that others would like me to eat more.

Never   Rarely   Sometimes   Often   Usually   Always

9. I throw up after I have eaten.

Never   Rarely   Sometimes   Often   Usually   Always

10. I feel very guilty after eating.

Never   Rarely   Sometimes   Often   Usually   Always

11. I think a lot about wanting to be thinner.

Never   Rarely   Sometimes   Often   Usually   Always

12. I think about burning up energy (calories) when I exercise.

Never   Rarely   Sometimes   Often   Usually   Always

13. Other people think that I am too thin.

Never   Rarely   Sometimes   Often   Usually   Always

14. I think a lot about having fat on my body.

Never   Rarely   Sometimes   Often   Usually   Always

15. I take longer than others to eat my meals.

Never   Rarely   Sometimes   Often   Usually   Always

16. I stay away from foods with sugar in them.

Never   Rarely   Sometimes   Often   Usually   Always

17. I eat diet foods.

Never   Rarely   Sometimes   Often   Usually   Always

18. I think that food controls my life.

Never   Rarely   Sometimes   Often   Usually   Always

19. I can show self-control around food.

Never   Rarely   Sometimes   Often   Usually   Always

20. I feel that others pressure me to eat.

Never   Rarely   Sometimes   Often   Usually   Always

21. I give too much time and thought to food.

Never   Rarely   Sometimes   Often   Usually   Always

22. I feel uncomfortable after eating sweets.

Never   Rarely   Sometimes   Often   Usually   Always

23. I have been dieting.

Never   Rarely   Sometimes   Often   Usually   Always

24. I like my stomach to be empty.

Never   Rarely   Sometimes   Often   Usually   Always

25. I enjoy trying new rich foods.

Never   Rarely   Sometimes   Often   Usually   Always

26. I have the urge to throw up after eating.

Never   Rarely   Sometimes   Often   Usually   Always

(Maloney et al., 1988)

TANNER STAGING SYSTEM

Tanner Staging Questionnaire
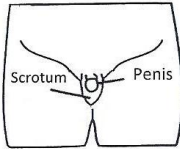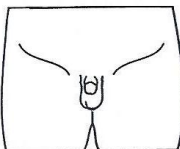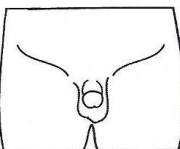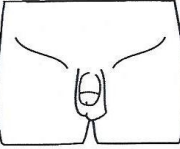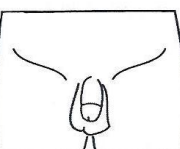
On each side of the line, please circle the number that *best represents* your child's pubertal status.

1. The breasts are flat.

2. The breasts form small mounds.

3. The breasts form larger mounds than in 2.

4. The nipple and the surrounding part (*the Areola*) make up a mound that sticks up above the breast.

5. Only the nipple sticks out beyond the breast.

1. No hairs.

2. Very little hair.

3. Quite a lot of hair.

4. The hair has not spread over the thighs.

5. The hair has spread over the thighs.
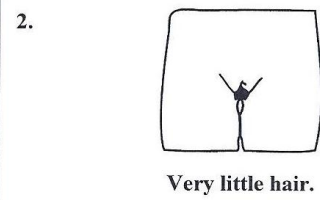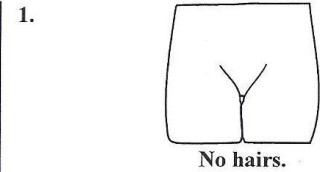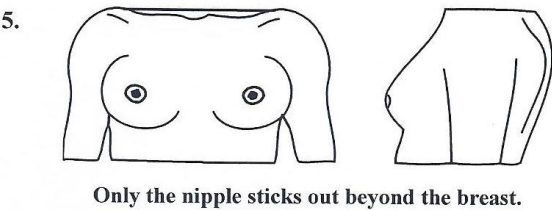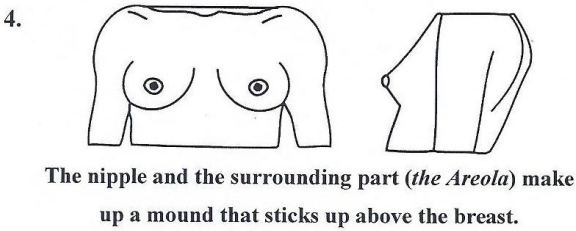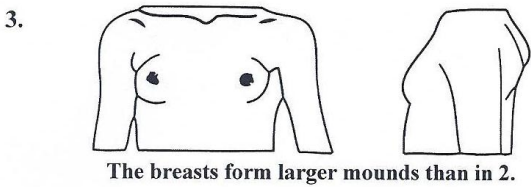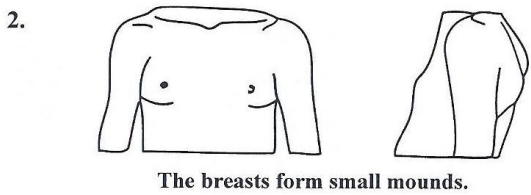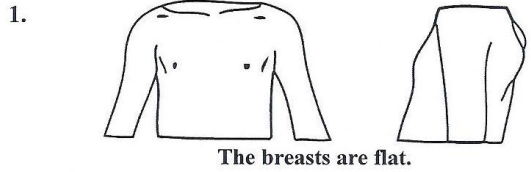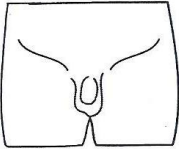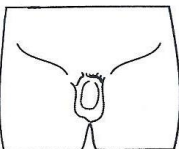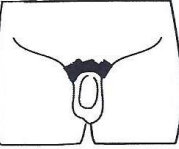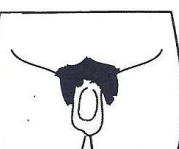
(Tanner, 1962)

Tanner Staging Questionnaire

On each side of the line, please circle the number that *best represents* your child's pubertal status.

1.

Scrotum   Penis

Scrotum and penis are the same size.

2.

The scrotum has lowered a bit and the penis is a little larger.

3.

The penis is longer and the scrotum is larger.

4.

The penis is longer and wider; the scrotum is darker and bigger than before.

5.

The penis and scrotum are the size and shape of an adult.

1.

No hairs.

2.

Very little hair.

3.

Quite a lot of hair.

4.

The hair has not spread over the thighs.

5.

The hair has spread over the thighs.

(Tanner, 1962)

APPENDIX H
ANTHROPOMETRIC FORM

Measures	Trial 1	Trial 2	Trial 3	Comments
Body Mass (kg)				
Height				
BMI (kg/m^2)				
Circumferences (cm):				
Waist - natural				
Waist – umbilicus				
Hip				

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