Protocol Title: **T**ranslational **I**nvestigation of **G**rowth and **E**veryday **R**outines in Kids (**TIGER Kids**)

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Purpose and Objectives

Project Summary

Increasing physical activity and reducing sedentary behavior are key recommendations of the *Dietary Guidelines for Americans* as a way to balance calories to manage healthy weight. However, few youth meet recommended levels of physical activity, and interventions to increase physical activity often have low adherence and high drop-out rates. Furthermore, health behaviors may be particularly compromised in children with severe obesity, which is the fastest growing sub-category of obesity. Severe obesity affects three times more African American children than White children.[1]

Precision medicine is a transformative approach to change health behaviors that considers individual characteristics and environmental context. Our interdisciplinary team at Pennington Biomedical Research Center will establish a prospective pediatric cohort to identify intervention targets based on the location, timing, barriers, and facilitators of current physical activity and sedentary behavior in a child's day. Examining activity profiles and contexts by obesity status and race will allow interventions to be further tailored for high risk groups. We will accomplish the project's aims by conducting a prospective examination of up to 345 African American and White girls and boys aged 10 to 16 years, including approximately 50% who are classified as severely obese. We will use state-of-the-art technology including accelerometry to quantify physical activity, magnetic resonance imaging to quantify fat accumulation, and global positioning system (GPS) information and ecological momentary assessment to identify environmental and socio-emotional barriers and facilitators. This project will identify opportunities in a child's day to naturally integrate physical activity and reduce sedentary behavior to achieve the overall goal of creating actionable strategies to improve health.

Study Objectives

Precision medicine is an emerging medical model that customizes healthcare decisions based on an individual patient's characteristics, aimed at delivering the right treatment at the right time.[2] A population approach to precision medicine takes into account environmental exposures.[3] As emphasized in the Scientific Report of the 2015 *Dietary Guidelines for Americans*,[4] multiple determinants of health from an individual's physical and socio-emotional characteristics to the environment in which they live influence treatment adherence and efficacy. The "Exercise is Medicine" initiative calls for healthcare providers to prescribe physical activity for the prevention, treatment, and management of chronic diseases.[5] An opportunity lies in leveraging precision medicine to create individualized physical activity plans for the prevention and treatment of obesity, a disease affecting 23% of Louisiana's children. To determine optimal, individually tailored exercise prescriptions, we must first identify the contexts within a child's day that facilitate physical activity and minimize time spent in sedentary pursuits, particularly among children with obesity. To achieve this aim, we will achieve the following objectives:

<u>Objective 1</u>: *Determine the effect of severe obesity on physical activity, sedentary behavior, and cardiometabolic risk factors during childhood and adolescence and whether these associations are modified by race (NP 107, C4, PS 4A).*

Hypothesis 1.A: Severe obesity will be associated with greater changes in physical activity, sedentary behavior, and cardiometabolic risk factors.

Hypothesis 1.B: Associations of severe obesity with physical activity, sedentary behavior, and cardiometabolic risk factors will be stronger among African American versus White youth.

<u>Objective 2</u>: *Investigate the contribution of (total, regional, and depot-specific) fat accumulation on changes in physical activity, sedentary behavior, and cardiometabolic risk factors during childhood and adolescence (NP 107, C4, PS 4A).*

Hypothesis 2: The accumulation of total, trunk, and visceral fat will be significantly associated with changes in physical activity, sedentary behavior, and cardiometabolic risk factors during childhood and adolescence.

Objective 3: Determine barriers and facilitators of physical activity that are related to obesity, including environmental and socio-emotional factors. (NP 107, C4, PS 4A).

Hypothesis 3.A: Environmental factors will be associated with physical activity.
Hypothesis 3.B: Socio-emotional factors will be associated with physical activity.

We specifically focus on health disparities among severely obese African American and White youth living in the Lower Mississippi Delta (LMD) region. The LMD represents one of the most medically underserved, at-risk populations living in the U.S, being characterized by high levels of poverty, food insecurity, obesity, and related diseases. Our Steps Ahead randomized clinical trial with LMD adults, supported by the ARS-funded Delta Obesity Prevention Research Unit, observed weight loss following a 12-week behavior change intervention, with those who received enhanced physical activity counseling losing more weight.[6] Realizing the need for prevention earlier in life, our plan will target LMD adolescents through a highly innovative and rigorously designed project using state-of-the-art technology, including accelerometers to objectively measure physical activity, global positioning system (GPS) devices to track location of the child's physical activity, and ecological momentary assessment to quantify the social context of the child's physical activity. This project is urgently needed to better design interventions that can be integrated into a child's daily life to produce clinically meaningful changes in children's weight status and cardiometabolic health.

The research will address a critical public health need: to identify times, locations, and contexts in a child's day that are optimal opportunities to increase physical activity. We will also examine whether activity patterns vary by obesity status and race in order to tailor physical activity prescriptions to groups at highest risk for obesity-related health complications. Once equipped with a precise profile of children's daily activities and environmental and socio-emotional contexts, we can create actionable strategies to improve children's health behaviors.

***Description of Problem to be Solved*:** Severe obesity, defined as having a body mass index (BMI) ≥ 120% of the 95th percentile, continues to rise among children and adolescents, with one-third of obese children currently being classified as severely obese.[1] Racial disparities in severe obesity exist: African American children have a 2 to 3 times higher prevalence of severe obesity than White children.[7] Though the role of physical inactivity as a contributor to the development of obesity is well established, we know far less about how obesity alters physical activity levels. Considering 17% of children are obese,[1] we urgently need to identify the impact of obesity on children's physical activity so that we can intervene early in the disease. The Scientific Report of the 2015 Dietary Guidelines Advisory Committee[4] recommends increasing physical activity and reducing sedentary behavior as a way to manage weight. Further, physical activity is recommended as first-line obesity treatment for children.[8] Yet only 8% of 12-15 year-olds meet national physical activity guidelines of 60 minutes of daily moderate-to-vigorous physical activity (MVPA).[9] Our research team has demonstrated that adolescents instead spend 7.5 hours per day sitting, with sitting more common among obese youth.[10] Physical activity programs are often hindered by high attrition (27% to 73% in a recent review[11]), due to inconvenience, transportation barriers, and scheduling conflicts.[12,13] Our project examines the influence of body fat and fat accumulation on the presence, proximity, location, and timing of physical activity and sedentary behavior in a child's day and whether these patterns vary by race. By examining facilitators to and barriers of physical activity, our project will inform new strategies about how to target children to increase physical activity and reduce sedentary behavior, particularly those children who rapidly accumulate body fat.

Background

Research Gaps

Our project will address two key research needs highlighted in the Scientific Report of the 2015 Dietary Guidelines Advisory Committee[4] by doing the following: 1) conducting prospective research to examine the relationships of quantity, patterns, and changes of physical activity and sedentary behavior with body weight, adiposity, and health in a diverse population of African American and White adolescents; and 2) using objective measures to assess the physical activities and sedentary behaviors in which adolescents regularly engage, without a reliance on self-report measures. Through the present project, we address the following gaps in scientific knowledge: the impact of severe obesity and fat accumulation on children's physical activity, sedentary behavior, and cardiometabolic risk factors; the activity profiles of children and how these profiles vary by obesity status and race; and barriers and facilitators of children's activity based on socio-emotional and environmental contexts. We will address these gaps by using state-of-the-art technology to quantify behaviors, environmental context, and health outcomes including accelerometry, clinical chemistry, magnetic resonance imaging (MRI), dual energy x-ray absorptiometry (DXA), global positioning system (GPS) information, and ecological momentary assessment (EMA). Each technological device and its potential for informing the identified research gaps are described below.

<u>Impact of Severe Obesity and Fat Accumulation on Children's Physical Activity</u>

We focus on severe obesity, the fastest growing sub-category of obesity[7,14] affecting between 4% and 6% of youth in the U.S.[15] This group of children is at highest risk for medical complications including heart disease, type 2 diabetes, and cancer.[15] Our research team, among others, has identified the importance of physical activity and low levels of sedentary behavior for children's health outcomes. In 2010-11, our research team conducted the WAIST study, which was a cross-sectional examination of 423 children and adolescents aged 5 to 18 years that were evenly distributed by age, sex, race (African American or White), and obesity status (PI: Peter Katzmarzyk, PhD, who is an Investigator on this project). Thus far we have published 8 manuscripts from this cohort.[16-23] We demonstrated that engagement in at least 60 minutes/day of physical activity on at least 4 days/week was related to lower body fat and lower visceral adiposity.[17] Conversely, sedentary behavior characterized by TV viewing was related to higher visceral adiposity and cardiovascular risk.[18] Indeed, 24% of the WAIST cohort already had at least 2 cardiometabolic risk factors at baseline (elevations in waist circumference, blood pressure, triglycerides, or fasting glucose, or low levels of high density lipoprotein cholesterol). The present project will build upon our prior work by investigating these relationships among adolescents who are classified as severely obese.

Although behavior modification that employs physical activity is considered the first-line treatment for severe obesity,[15] we know very little about current patterns of physical activity or the barriers and facilitators of physical activity among children with severe obesity. A scientific statement from the American Heart Association in 2013 issued an appeal for innovative behavior-based treatment and minimally invasive procedures to treat severe obesity in children and adolescents.[15] Few lifestyle modification studies have focused on children with severe obesity, and interventions that do include this population have not taken into account environmental or socio-emotional factors related to children's health behaviors. Family-based behavioral treatment that employs physical activity, dietary counseling, and behavioral strategies to implement and sustain changes have had limited long-term success,[24-27] with many children returning to baseline weight following the completion of the intervention.[24,25,28]

In response to the paucity of data and the lackluster response to lifestyle interventions, two urgent research needs emerged: 1) to characterize the relationship of severe obesity with children's behavioral and environmental contexts and 2) to identify weight-gain trajectory data that differentiate children at high risk who need intensive intervention to promote healthy behaviors.[15] The present project will provide important data for both the association of severe obesity with children's physical activity and sedentary

behavior (Objectives 1 and 3) and the identification of fat accumulation as a risk factor for inactivity (Objective 2).

Obesity and fat accumulation are often assessed using anthropometric measures such as body mass index z-score (BMIz) based on height and weight. Though useful to classify obesity status at a population level, we will use more precise and direct quantification of fat accumulation via MRI and DXA. Health consequences associated with obesity differ based on where adipose tissue is stored, for instance subcutaneously between the skin and muscle versus internally, such as within the chest, abdomen, and pelvis (i.e. visceral fat).[29] Using the WAIST cohort, our research team observed that trunk fat, which is fat located centrally in the body excluding the extremities, affects adolescents' metabolic risk.[18] Recent advances in body composition imaging allow for the examination of specific depots of fat in the pediatric population, providing sufficient precision to evaluate individual and group differences and to track changes in fat mass over time. Our research team previously identified through an extensive literature review that there are little data available on visceral fat in children and adolescents, and even less data measured in a longitudinal fashion over time.[30] Through an examination of the cross-sectional data from the WAIST cohort, we identified ethnic and sex differences in visceral fat.[16] However, we do not know how the accumulation of trunk or visceral fat affects physical activity, sedentary behavior, or cardiometabolic risk factors. A systematic review of 32 studies indicated a relationship among children's fat gains with reduced physical activity and increased sedentary behavior, but stronger measurement methods and stratification by subgroup are needed.[31] Therefore, the present project will provide important, timely data on the association between fat accumulation and children's activity levels using MRI and DXA technologies in a diverse sample of children and adolescents.

Activity Profiles and How Activity Varies by Obesity Status and Race

There is a dearth of data on the activity profiles of children and adolescents, particularly those with severe obesity and from ethnic minority groups. We will gather information on the location, frequency, intensity, and timing of physical activity and sedentary behavior in children during free-living conditions, providing precise profiles of children's activity patterns. To do so, we will use accelerometry, which is the gold standard to assess free-living physical activity and highly correlated with oxygen consumption or direct observation of physical activity.[32]

This project makes three novel contributions to profiling children's activity: 1) by quantifying sedentary behavior with accelerometry, GPS, and EMA simultaneously, extensively characterizing free-living activity; 2) by examining differences in activity profiles by obesity status; and 3) by focusing on African American youth who are at particularly high risk for obesity and obesity-related health problems. Sedentary behavior, which is activity occurring at the lowest end of the intensity spectrum typically in the posture of sitting or lying down, has emerged as an independent risk factor for obesity-related comorbidities by our team[33] and others.[34] Identifying the contexts and facilitators of sedentary behavior will inform actionable strategies to reduce sedentary behavior in children's daily lives.

Obesity is an important risk factor for low physical activity and high sedentary behavior, but it is not clear how activity profiles differ based on obesity status. A study of 507 children aged 9 to 11 years demonstrated that accelerometer-measured MVPA was inversely associated with adiposity regardless of sedentary time or sleep duration,[35] yet associations were cross-sectional and adiposity was measured by bioelectrical impedance rather than DXA or MRI. The present project will build on prior work by examining the influence of longitudinal changes in fat, including depot-specific fat in the trunk and visceral regions, and subsequent health behaviors, with a focus on children with severe obesity.

We also focus on health disparities between African American and White youth and whether differences may occur in the association between obesity and health behaviors. To do so, we leverage our diverse population in the Louisiana LMD and target African American youth, a group with high levels of severe obesity[14] and therefore at particularly high risk for obesity-related health problems. Approximately 44%

of African American men and women have cardiovascular disease, compared to 36% of Whites. African Americans experience higher prevalence of hypertension (48% vs. 24%) and almost double the prevalence of stroke (4.5% vs. 2.4%).[36] In addition, there is a higher prevalence of obesity (37.1% vs. 32.4%) and severe obesity (6.9% vs. 3.8%) among African Americans compared to Whites.[37,38] These differences in chronic disease prevalence translate into greater morbidity and mortality for African Americans.[39,40] Our research team has previously demonstrated that compared to Whites, African American adolescents have more total body fat but less visceral adiposity.[16] Prevention efforts are clearly needed to reduce racial disparities in cardiovascular disease, and understanding health disparities in behaviors at a younger age will inform prevention and treatment strategies for African Americans.

Barriers and Facilitators of Children's Activity

The barriers and facilitators of children's activity are not well documented and have largely relied on self-reported data. We employ two novel methods to examine the environmental and socio-emotional context of children's activity.

Global positioning system (GPS). GPS technology has recently emerged as a way to measure the location of behaviors and subsequently link these location data to proximal physical activity facilitators such as parks and sidewalks or barriers such as neighborhood crime. It is becoming increasingly recognized that social determinants contribute to health disparities.[41,42] For example, African Americans are more likely to live in lower socio-economic status neighborhoods, which have been characterized by poor sidewalk conditions,[43] unpleasant aesthetics,[44-46] lower safety,[45-46] higher social disorder and lower social capital,[46] and less access to physical activity facilities.[45,47-49] Also, these social determinants are related to lower levels of physical activity and higher levels of obesity; for example, lower access to physical activity facilities is associated with decreased odds of engaging in the recommended amount of MVPA and higher prevalence of obesity.[47] In the WAIST cohort, our research team demonstrated that children living in high poverty/crime neighborhoods were at higher risk for elevated C-reactive protein, a marker of cardiovascular risk.[19]

Both obesity and low levels of physical activity contribute to poor cardiovascular health, and therefore, are targets for intervention. However, the effectiveness of interventions targeting physical activity or obesity may be affected by environmental factors.[50-52] In an intervention that substituted physical activity for sedentary behavior, Epstein and colleagues showed that children living within 0.5 miles of a park increased their physical activity more than children not living near parks.[53] Also, Investigators Robert Newton, PhD and Stephanie Broyles, PhD conducted a pilot randomized trial comparing an intensive and a minimal mobile phone-based intervention designed to promote physical activity in children (Industry funded; Newton, PI).[54] Data from this pilot study (P-Mobile, n=27) found that lower neighborhood crime was associated with a larger increase in physical activity and that treatment response was highly correlated with crime in the intensive intervention group (manuscript under review). The project will examine the specific environmental factors that contribute to and impede physical activity and sedentary behavior in order to better design effective interventions.

Ecological momentary assessment (EMA). EMA is emerging as a real-time method to measure the subjective and contextual barriers and facilitators of physical activity and sedentary behavior. EMA involves sending messages over a mobile device throughout the day for the participant to record descriptions of activities undertaken as well as socio-emotional factors such as who the child is with and how the child is feeling. Responses are provided in real-time in a naturalistic setting, offering minimal interference in a child's typical day. Importantly, EMA has been validated with objective physical activity measures in children[55] and has demonstrated acceptable compliance (76.8% response rate among 121 children sampled over 4 days).[56] EMA is an alternative to traditional recall instruments that are limited by participants' memory errors and biases and that are not completed in an environment where the behavior occurred. EMA is also an alternative to observational methods, which are limited to a specific setting (e.g. a park, an artificial environment created in a laboratory) and cannot capture subjective perceptions such as

mood. In summary, EMA has been demonstrated to be a valid, reliable, feasible approach to quantify physical activity and sedentary behavior.[57]

Because EMA is an emerging technology, its potential to profile children's free-living activities remains untapped. Dunton and colleagues applied EMA to a sample of 121 children aged 9 to 13 years and uncovered several barriers and facilitators to physical activity in this age group: physical activity most often occurred in a social context when other people were present,[56] children were more active in settings where they perceived less traffic,[58] and children's feelings of tiredness and energy predicted physical activity, which in turn predicted subsequent emotional states.[59] Though the sample surveyed was ethnically diverse (i.e. 38% Hispanic/Latino), African American youth were not represented, and the sample was younger (9 to 13 years) and had a healthier weight status (61% were normal weight or underweight, 18% were overweight, and 21% were obese) than the proposed sample. Indeed, the present project will be the first to our knowledge to apply EMA to a large sample of children with severe obesity and to use EMA among a sample composed of 50% African American children.

Inclusion and Exclusion Criteria

We will include adolescents aged 10 to 16 years. We selected this age range because adolescence is a developmental period of rapid fat gain and changes in activity patterns. By choosing the maximum age as 16 years at baseline, the children are likely to still live in Baton Rouge and attend high school at the second clinic visit (age 18 years), facilitating follow-up.

Inclusion Criteria:

- Age 10-16 years
- Body weight < 500 lbs.
- Ability to understand instructions and complete all study procedures

Exclusion Criteria:

- Pregnant
- On a restrictive diet due to illness
- Significant physical or mental disabilities that impede walking, wearing accelerometer or GPS, or responding to EMA.

In addition to the exclusion criteria listed above, participants who refuse to provide written assent, or whose parents or legally authorized representative refuse to sign an informed consent document, will be excluded from the study. Consent/assent will be obtained upon each participant's arrival at the PBRC Pediatric Research Clinic before participating in any study procedures. To further safeguard participant safety and internal validity of the study, inclusion and exclusion criteria will be reassessed by PBRC clinic staff following the completion of required assent/consent forms. The principal investigator and medical investigator have the right to withdraw a participant from the study at any point for any reason.

Number of Participants

We will identify and recruit up to 345 boys and girls aged 10 to 16 years. The sample will be screened on the telephone in attempt to achieve a comparable sex and race distribution. We will oversample for severely obese youth so they comprise approximately 50% of the sample (with the other 50% being distributed among normal weight, overweight, and obese status).

Recruitment Methods

Recruiting children for clinical studies is challenging, particularly those from high risk populations such as with severe obesity and from ethnic minority groups. However, we are confident we can recruit up to 345 children within 2 years. A key recruitment strategy will be to enroll participants who completed the WAIST Study.[16] Of 423 initial participants who were assessed for the WAIST Study in 2010-11, 386 (91.3%) agreed to be re-contacted. Of these, 193 participants will meet the age criteria for the follow-up

study (i.e. age 10 to 16 years in the year 2016). Therefore, we will have a sample of approximately 193 participants to immediately recruit into this new study.

Participants will also be recruited from the Greater Baton Rouge area via website advertisements and emails. We will use a variety of recruitment strategies include flyers in pediatric clinics (affiliated with Our Lady of the Lake), health fairs, community events, local schools, local businesses/organizations, and other strategies. For recruitment in schools, we will obtain permission to promote the study at each school from the school district superintendent (if necessary) and individual school leaders (principals, headmasters, directors, etc.) prior to recruiting in that school. School recruiting efforts will include communications about the study that may be distributed to students or sent to parents directly. These communications may include informational flyers, posters, letters, emails, newsletters, school call services, and consents through which parents may provide contact information and request to learn more about the study, among others. Study staff may also attend schools in person to promote the study at school events which the school deems appropriate, including attending physical education/health classes, lunch periods, school assemblies, parent nights, and other school events. In-person efforts may include, but are not limited to, making announcements about the study, distributing informational materials, and/or demonstrating procedures used in the study. We will work closely with each school to tailor recruiting efforts based on each school's rules and preferences.

The Pennington Biomedical recruitment core will execute a plan to advertise through branches of the public library system, seek the support of community leaders, issue personal appeals through social organizations, place advertisements in places of congregation (i.e. libraries, churches), and conduct direct mailings, as well as advertisements via newspaper, radio, and television. Our recruitment plan is based on strategies that have resulted in investigators successfully reaching their recruitment goals: 1023 children and adolescents for cross-sectional obesity screening studies (Investigator Katzmarzyk)[16] and 1043 children and adolescents into physical activity and dietary interventions (Project Lead Staiano and Investigator Newton).[78-81] Baton Rouge area has an estimated 2013 population of 445,277 and almost 46% of the population is African American.[82] Even with anticipated loss to follow-up, we will have sufficient power in overall logistic regression analyses.

Recruitment will begin in the spring of 2016 and is expected to end in the spring of 2018.

Study Timeline

Participants will be enrolled on a continual basis over the course of 24 months. Participation in the study will last approximately 2 years. It is estimated that the investigators will complete primary analysis by December 2019. The study timeline is reported in **Table 1**.

	2016			2017				2018				2019		
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Personnel Training														
Participant Recruitment														
Baseline Testing, Y0														
Follow Up Testing, Y2														
Data Management														
Data Analysis Y0														
Paper Writing & Submission, Y0														
Data Analysis Y2														
Paper Writing & Submission, Y2														

Table 1. Study Timeline

Procedures Involved

Study Design

We will conduct a prospective epidemiological study to determine the effect of severe obesity on physical activity, sedentary behavior, and cardiometabolic risk factors among African American and White children and adolescents. Physical activity, sedentary behavior, cardiometabolic risk factors, and body composition will be assessed in each participant using gold standard, objective measures, with the first assessment (Year 0) in 2016-17 and the second assessment (Year 2) in 2018-19. We previously observed that children's physical activity and other health behaviors vary throughout the year based on school term versus school holiday.[60] Therefore, each child's Year 0 and Year 2 clinic visits will be scheduled at a consistent time of year to protect against changes due to the child being in school term or on a school holiday. Furthermore, we will use a scheduled enrollment to ensure that clinic visits are representative of both school term and school holidays.

Following an initial recruitment telephone screen or web-screen (followed by a telephone screen) to assess initial eligibility criteria, eligible participants will be scheduled for their Orientation visit at PBRC with their parent or legally authorized representative where participants will be formally oriented to the study by receiving detailed information on the purposes, goals, procedures, participant flow, and study timeline. Staff will obtain signed informed consent and child assent before participants take part in any of the study-related procedures. Participants will be given the GPS and accelerometer devices as well as instructions on how to wear them for the next week. Participants will also be given the EMA application on their personal cell phones or a provided mobile device along with instructions on how to respond to the prompts for the next week. Participants will be introduced to the ASA-24 dietary intake tool and provided instructions on how to complete two separate recalls from their home computer prior to the Year 0 clinic visit. Participants and parents may be asked to complete surveys on the devices while waiting. At the conclusion of the Orientation session, participants will be scheduled for their Year 0 clinic visit within 8-21 days after the Orientation. Parents may receive reminders from staff for all tasks required of participants between orientation and Year 0.

Participants will be fasting at the Year 0 visit. Measurements including anthropometry, blood draw, urine pregnancy test, body composition, dietary intake, activity monitor tracking equipment collection, and all remaining surveys will take place during the clinic visits. Participants must be accompanied by a parent or legally authorized representative at the clinic visits.

Approximately 10 days prior to the Year 2 visit, participants will pick up an accelerometer and GPS device to wear for 7 days and return at the Year 2 clinic visit. Participants will also be given instructions on how to complete two trials of the ASA-24 dietary intake tool from their home computer prior to the Year 2 clinic visit. Participants will return to clinic approximately 2 years (+/- 6 months) after their Year 0 visit for a Year 2 visit, in which all procedures collected during Year 0 will be repeated. **Table 2** includes a list of all measurements occurring at both visits. Parents may receive reminders from staff for all tasks required of participants between orientation and Year 2.

Measurements

	Orientation	Year 0	Year 2
Informed consent/assent	X		
Anthropometry (Height, weight, waist size)		X	X
Blood Pressure		X	X
Body Composition (DXA, MRI)		X	X
Blood Draw		X	X
Urine Pregnancy Test (eligible females only)		X	X
Dietary Intake (ASA-24)		X	X
Family environment surveys		X	X
Neighborhood environment surveys		X	X
Body image and mood surveys		X	X
Global Positioning System (GPS)	7-days		7-days
Physical Activity (Actigraph GT3X+)	7-days		7-days
Ecological momentary assessment (eMA)	7-days		

Table 2. Study procedures

Description of tests and procedures

Anthropometry

Weight- Anthropometry will be measured to the nearest 0.1 cm (0.1 kg for weight). All measures are taken twice with the analyzed value being the average of both measurements. If the measures differ by greater than 0.5 units, a third measurement will be taken to replace the discrepant value. Participants wear only a hospital gown and undergarments while being weighed.

Height- Standing height will be measured using a Harpenden stadiometer (Holtain Limited, Crymych, UK). Participants will remove shoes, stand upright with heels and back against the stadiometer, inhale, and hold breath while an assessor provides traction to align the participant's head along the Frankfort Horizontal Plane during measurement. Weight will be measured using a Michelli GSE 460 scale (G.T. Michelli Co., Baton Rouge, LA).

BMIz- BMI percentile and BMIz will be calculated based on the participant's age, height, and weight using the CDC 2000 growth charts.[61] Severe obesity will be categorized as ≥ 120% of the 95th BMI percentile.[15]

Waist circumference - will be measured at the natural waist (halfway between inferior border of rib cage and superior aspect of iliac crest) with clothing moved out of the way.

Body composition

DXA- Total body fat and trunk fat will be assessed by whole-body DXA using a GE iDXA scanner (GE Medical Systems, Milwaukee, WI) to quantify total and regional body fat (including trunk fat).

> *DXA Instructions given to participant*: This scan measures the amount of bone, muscle, and fat in your body. The scan will be performed using a whole-body scanner. You will be required to wear a hospital gown, to remove all metal-containing objects from your body, and to lie down on the table. You will be carefully positioned on the table, and your legs will be placed together using two Velcro straps. A scanner emitting low energy X-rays and a detector will pass along your body. You will be asked to remain completely still while the scan is in progress. The scan takes approximately ten minutes.

MRI - Visceral fat, i.e. visceral adipose tissue, will be assessed by water-fat shifting MRI using the General Electric Discovery 750w 3.0 Tesla (GE Medical Systems, Milwaukee, WI). IDEAL-IQ imaging technique will be used to generate water-only, fat-only, in-phase, and out-of-phase echoes in a single acquisition with a 20-second breath-hold. For female subjects ages 12 and above or females under the age of 12 who are menstruating as verbally confirmed by a parent or legal guardian, a negative urine pregnancy test will be required prior to DXA or MRI scans.

> *MRI instructions given to participants:* For this test, you will be asked to change into a hospital gown. You will be given earplugs. You may be given a blanket to keep you warm as needed. You will lie on a table in the MR scanner and lie as still as possible to measure the amount of fat, muscle, and other tissues inside your abdomen as well as the size and functioning of internal organs. Foam padding will be provided as needed to insure that you are able to lie down comfortably. A device called a "coil" will be placed over your abdomen to collect the images. After the coil is placed over your abdomen, you will be asked to lie as still as you can for about 10 to 50 minutes while the machine collects images of your body.
>
> You may be asked to hold your breath repeatedly for 10 to 15 seconds during this scan. The purpose of holding your breath is to collect higher quality images of your abdomen. Breathing causes your internal organs to move up and down in a rhythmic and natural way. For some magnetic resonance scanning techniques, this natural motion makes the images blurry. If holding your breath makes you dizzy or lightheaded, the scan will be discontinued for your safety.
>
> During the scan, you may be asked to wear devices that record the beating of your heart, your breathing, and the circulation of blood to your extremities. Sticker-like electrocardiography pads will be attached to your chest and wires will be attached to those pads. This device will record the beating of your heart. A belt-like breathing monitor will be strapped around your chest to record the rise and fall of your chest due to your natural breathing. A pulse oxygenation monitor is a small device that will clip onto your fingertip to record how much oxygen is in the blood that circulates from your heart to your fingertips. If any of these devices cause you discomfort, the scan will be discontinued. Some magnetic resonance scanning techniques are affected by the rhythm of your breath and the rhythm of blood flow from the heart. These devices help us to remove this effect from the scans so that we can better measure the structure and function of bodily tissues.
>
> You may be asked to come back to the Pennington Center and repeat this test if we have an unforeseen problem collecting the scan on your first visit.

Blood draw

A fasting sample of blood will be taken by a trained phlebotomist following standardized clinic procedures. The participant will be offered EMLA cream (lidocaine 2.5% and prilocaine 2.5%) to minimize pain related to blood draws. Serum concentrations of glucose, triglycerides, low density lipoprotein cholesterol (LDL-C), and high density lipoprotein cholesterol (HDL-C) will be obtained from a DXC600 manufactured by Beckman Coulter. Serum CRP levels are determined by immunoassay with chemiluminescent detection, run on an Immulite 2000 manufactured by Siemens. Insulin will be assayed on the Siemens Immulite 2000. Approximately two teaspoons of blood will be collected.

An aliquot of whole blood and aliquot of serum will be stored in case further tests are needed and if further consent is obtained from the subject.

Cardiometabolic risk factors

Resting blood pressure – will be assessed using standard clinical procedures on a standard sphygmomanometer.[62]

Cardiometabolic risk factors - Elevated cardiometabolic risk (i.e. metabolic syndrome) will be categorized as the presence of three or more cardiometabolic risk factors using the established criteria in the 2011 National Institutes of Health Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents.[63]

24-hour Dietary Recall (ASA-24)

The focus of this project is physical activity and sedentary behavior, yet dietary intake is a critical component to energy balance and weight gain.[4,15] Therefore, dietary intake will be assessed to characterize children's energy balance so that the effects of physical activity and sedentary behavior on obesity can be isolated from dietary intake. Dietary intake will be monitored by the NCI Self-administered 24-hour Dietary Recall (ASA24 ™). The 24-hour dietary recall is considered the gold standard to assess free-living diet in children.[69] The ASA24™, which has been used in over 300 clinical trials,[70] was developed to be automated and self-administered, enabling the efficient administration of multiple recalls in large-scale epidemiological studies such as the present study. The format and design are adapted from the interviewer-administered Automated Multiple-Pass Method (AMPM) developed by the USDA. The ASA24™ has been validated with 80% accuracy vs. 83% in AMPM, based on inconspicuous observation of adults consuming an ad libitum buffet meal.[71] Parents will assist children in completing the instrument, and trained staff will be available to answer questions. Participants will complete the ASA24 survey outside of clinic two more times at each visit time point within approximately one week of the completed clinic visit. Surveys will be completed twice on a week day and once on a weekend at Year 0 and again at Year 2. Dietary patterns derived from principal components analysis will be used as a covariate and tested as a mediator in the proposed analyses.

Accelerometer

Physical activity and sedentary behavior will be measured by a triaxial accelerometer (Actigraph GT3X+, Actigraph of Ft. Walton Beach, FL). The participant will be instructed to wear the accelerometer on an elasticized belt, on the left mid-axillary line. The Actigraph is one of the most common accelerometers used for scientific purposes. Participants will be encouraged to wear the accelerometer 24-hours per day for at least 7-days (plus an initial familiarization day and the morning of the final day), including 2 weekend days. A 7-day monitoring protocol provides reliable estimates of children's free-living physical activity behavior.[64] The nocturnal sleep period will be identified and removed based on a fully automated, validated algorithm.[65,66] The minimal amount of accelerometer data that will be considered acceptable is 4 days with at least 10 hours of awake wear time per day (excluding the sleep period), including at least one weekend day. The 10 hour/day minimum is the standard in the field and was used by nearly all of the 54 articles reviewed in a recent systematic review.[67] The requirement of at least 1 weekend day was selected because children's physical activity varies between weekday vs. weekend day.[64,67] Following the final day of data collection, the research team will verify the data for completeness using the most recent version of the ActiLife software (version 5.6 or higher; ActiGraph, Pensacola, FL). The research team will ask children to wear the accelerometer for additional days (to a maximum of 14 days) to ensure that the minimal data requirements are met. Cutpoints will be assigned based on Evenson et al.,[68] with 0 to 25 counts per 15-second epoch (CPE) classified as sedentary, 26 to 573 CPE as light, 574 to 1002 CPE as moderate, and ≥ 1003 CPE as vigorous. The Evenson et al. cutpoints were selected because data are collected in 15-second epochs which allows for fine-tuned analysis of the sporadic nature of children's physical activity. For the purposes of statistical analysis, sedentary behavior will be defined as ≤ 25 CPE and MVPA as ≥ 574 CPE.

Portable global positioning system (GPS) device

To identify where physical activity occurs, children will wear the QStarz BT Q1000XT data logger for 7 days concurrent with the ActiGraph GT3X+. This GPS device will attach to the same elastic belt holding the ActiGraph GT3X+. This portable GPS works up to 20 hours (in our experience other devices have a longer battery life, but poorer satellite receptivity) when set at 15 sec epoch acquisition. Because the GPS data will be matched to the accelerometry data, the minimal amount of GPS data that will be considered acceptable is identical to that of the accelerometry data: 4 days with at least 10 hours of awake wear time per day (excluding the nocturnal sleep period), including at least one weekend day. Parents will be provided a charger to charge the GPS at night after removal. With reminder calls and e-mails from research staff (including links to the device-use video), this procedure has worked well previously. GPS allows for the identification of physical activity locations and routes.[83] Portable GPS technology appears particularly accurate at detecting outdoor walk trips where the GPS device has sky view, with accuracy only slightly attenuated when the device is obstructed.[84] The introduction of more reliable and less expensive equipment to provide location and speed data in time-linked formats[85] has led to GPS adding significantly to physical activity duration and intensity data obtained through accelerometry, including improvements in estimating distance and time, as well as improved accuracy in detecting walking trips.[86,87]

Surveys

Medical History Survey

Parents will complete a survey detailing the participant's medical history and medication use as well as the biological parents' medical history, if known.

Lifestyle Survey

Participants will complete a survey to collect information about lifestyle, including diet and physical activity habits, quality of life, friends, confidence, smoking status, and media use. Participants will also be asked to report on their stage of sexual maturation, based on a series of standardized, validated drawings depicting progressive stages of pubertal development from 1 (no development) to 5 (complete development) for female breasts or male genitalia and from 1 (no development) to 6 (complete development) for pubic hair development (Tanner, 1986).

IWQOL-Kids

Participants will complete a survey to collect information about how the participants body weight affects their quality of life, such as physical comfort, body esteem, social life, and family relations.

Resilience Scale (CD-RISC 10)

Participants will complete the 10-item Connor-Davidson Resilience Scale survey to collect information on resilience, which is the ability to thrive despite adversity. The 10-item unidimensional scale has showed excellent psychometric properties including good internal consistency and construct validity.[118]

Sociodemographics Survey

Parents will report race, ethnicity (i.e. Hispanic), household income, and parental education. These variables will be used as potential covariates in analyses.

Family Environment Survey

Several aspects of the family environment will be measured via parent-reported questionnaire.[88,89] The survey we use pertains to children living in a household with parents. The baseline maximum age is 16 years, so we expect all participants to be 18 years and still enrolled in high school at follow-up. However, if any participants no longer live at home, the participant will only complete the physical activity equipment part of this survey. Parents will report the following:

a) physical activity equipment: presence of items at home that facilitate physical activity; internal consistency for this scale has been shown ($\alpha = 0.75$);[89]

b) family structure: marital status and the number and age of children living in the home;
c) household rules: parental rules regarding physical activity;[88]
d) parent physical activity support: parental support for their child's physical activity over the course of a typical week;[88] these four items have been shown to be internally consistent (α = 0.75);[89]
e) parent physical activity behavior: the Aerobics Center Longitudinal Study Physical Activity scale is a self-report measure of current levels of physical activity; this measure asks about various activities and the amount of time spent on each activity, on average and has been shown to be psychometrically sound;[90] and
f) sibling physical activity behavior: amount of physical activity for each child over the course of a typical week, including frequency, time, location and type.[91]

Constrained Behaviors Questionnaire
Parents will be asked to answer questions regarding their constrained behavior, which are parenting behaviors that restrict their child from outdoor play in their neighborhood (i.e. avoidance and defensive behaviors). This measure was validated by Carver et al., 2010.-[119]

Neighborhood Impact on Kids (NIK) Survey
Parents (or participant if age is ≥ 18 years) will be asked to report on various aspects of the neighborhood environment, via a questionnaire adapted from the Neighborhood Impact on Kids (NIK) study survey (PI Dr. Brian Saelens, who serves as Consultant on this project),[91] which drew on questions from other validated instruments. We have used this questionnaire in other studies.[54,95] The questionnaire includes items related to neighborhood social capital (collective efficacy and the degree to which neighbors know each other and engage socially) and the neighborhood physical activity environment and built environment (access to and use of various places where a child can be physically active, and the suitability of the neighborhood environment for walking and physical activity). To measure the child's perception of the neighborhood environment, we will use a short validated survey for the child to report his/her perceptions of access to neighborhood destinations, perceptions of neighborhood aesthetics and safety, and perceptions of the neighborhood social environment.[96]

Body Image Assessment Procedure for Preadolescents (BIA-P) and Mood and Feelings Questionnaire
The participating child will complete the Body Image Assessment Procedure for Preadolescents (BIA-P),[99] which has been demonstrated as reliable and valid in the adolescent age period.[99,100] The child will also complete the Short Mood and Feelings Questionnaire (SMFQ), a 13-item scale which has been validated in a community sample of children and adolescents to self-report depressive symptoms.

Body dissatisfaction and negative mood have both been shown to influence health behaviors and weight status in adolescents, making both of these factors relevant in the present investigation. Research has shown that a higher level of body dissatisfaction not only perpetuates health-compromising behaviors, such as unhealthy weight control methods and binge eating, but also hinders health-promoting behaviors, such as vegetable intake and participation in physical activity.[102] In general, research indicates that negative body image (higher body dissatisfaction) does not serve as a motivator for engaging in healthy weight management behaviors, but rather predicts the use of behaviors that may place adolescents at risk for overall poorer health and weight gain.[102]

Health-Related Qualify of Life (KIDSCREEN-10 Index)
Health-related quality of life will be assessed using the KIDSCREEN-10 Index, designed to evaluate quality of life in children and adolescents with a chronic illness.[115,116] The index includes questions on energy, sadness, loneliness, fun with friends, and performance at school. The psychometric properties of this index are such that the distribution of raw-scores resembles the theoretical expected normal distribution. Thus the index provides a good discriminatory power along the HRQoL-trait-continuum,

shows only few ceiling/floor effects, and even raw-scores may provide interval-scaled HRQoL measurement. In addition the good internal consistency reliability (Cronbach's Alpha = .82) and the good test-retest reliability / stability (r = .73; ICC=.72) enables a precise and stable HRQoL measurement. Additional statistical analyses show that the KIDSCREEN-10 Index is able to differentiate between different groups. Children and adolescents with a low score on the family affluence scale (FAS, effect size d=.47), with behavioral problems (SDQ, effect size d=.1.30) and with a high number of psychosomatic complaints (d=1.69) display significantly lower health related quality of life in comparison to the respective comparison group.

Food Security Questionnaire
Parents of participants will complete the American Academy of Pediatrics' Food Security Questionnaire, a self-reported assessment of the family's financial situation in regards to food security within the past year.

Stress Questions (PECK)
The Personal Experiences Checklist provides a self-report assessment of a young person's personal experience of being bullied. The measure is suitable for both girls and boys aged 8 to 16 years and it covers the full range of bullying behaviors, including covert relational forms of bullying and cyber bullying. There are four subscales: physical, relational, cultural, and cyber.

- *Hunt, C., Rapee, R.M., & Peters, L. (2012). Development of a measure of the experience of being bullied in youth. Psychological Assessment, 24 (1), 156-165.*

Food Craving Inventory (FCI)
The food craving survey is a self-reported measurement of how often the participant experiences a craving for listed foods. The survey is 33 items long, and includes various foods and beverages. Participants will indicate on the survey how many cravings he or she has had in the past month.

- White M, et al. Development and validation of the food-craving inventory, Obes Res. 2002;10:107-114.
- Geiselman P et al. *Reliability and validity of a macronutrient self-selection paradigm and a food preference questionnaire*. PHYSIOL BEHAV. 1998; 63(5): 919-928.

Neighborhood Perception Survey
Participants will complete this validated survey to measure the child's perception of his or her neighborhood environment. The self-reported survey indicates the child's perception of access to neighborhood destinations, perceptions of neighborhood aesthetics and safety, and perceptions of neighborhood social environment.

- Hume C, Salmon J, Ball K. Associations of children's perceived neighborhood environment with walking and physical activity. Am J Health Promot. 2007; 21:201-207.

Sibling Relationship Questionnaire (SRQ)
Participants with sibling(s) who are also enrolled in the study will complete a shortened version of the Sibling Relationship Questionnaire (Furman and Buhrmesters 1985) for each sibling in the study. Participants will be asked to gauge the quality of their sibling relationships through questions related to the constructs of prosocial, affection, companionship, similarity, intimacy, admiration of sibling, and admiration by sibling. A psychometric analysis of this questionnaire was examined among a sample of 428 adolescents and confirmed that stated seven constructs form an overall factor of warmth/closeness.

- Derkman MS, Scholte RHJ, Van der Veld WM, Engels RCME. Factorial and construct validity of the Sibling Relationship Questionnaire. Eur J Psychol Assessm 2010;26(4):277-283.
- Furman W & Buhrmester D. Children's perceptions of the qualities of sibling relationships. Child Development 1985;56(2):448-461.

mHealth Weight Management Program Acceptability Survey
Parents will complete a survey assessing program acceptability for an mHealth weight management program that teaches the parent and child dietary, physical activity, and behavioral change strategies.

Cyber Cycling Lifestyle Program Acceptability Survey
Parents will complete a survey via REDCap assessing acceptability for an exercise and healthy eating program for adolescents and young adults.

COVID-19 Survey
Parents will be asked to complete a survey related to the stay at home order that families were under due to the COVID-19 pandemic. The survey will be sent out via email using REDCap, where parents can click that they consent to completing the additional survey. Participants that have already completed the Year 2 visit will also receive the survey link, with an option to complete it. Parents will be asked to report on information related to their child's behavior habit changes, such as sleep, physical activity, diet and screen time.

Environmental Assessment and Analysis

Neighborhood environment

A participant's neighborhood will be defined as the 3/4-mile street network buffers around each child's residence (walkable distance from home), and neighborhood features will be enumerated within the buffers (see Colabianchi et al., 2014 as an example).[92] Physical activity patterns will be characterized according to whether the physical activity occurs within 3/4-mile of the child's residence or not. As a point of comparison, the secondary definition of neighborhood environment will be the Census Block Group (BG) in which he/she resides. This definition has been used in other recent work assessing environmental influences on children's physical activity[93,94] and is expected to be a good scale on which to measure the influence of neighborhood disorder and social processes.[93]

> *Objective measures: park access and crime.* Park access has been determined based on a comprehensive list of public parks in the four parishes (counties) surrounding Baton Rouge, LA maintained by Dr. Broyles (Investigator for the present project). This list is constantly updated and will be verified prior to recruitment. A BG will be considered to have park access if any boundary of a park is located either within the BG or within a 0.25-mile buffer around the BG, corresponding to similar research.[94] Distance from participant residence to nearest park will be calculated within the ArcGIS 9.2 software program and will be used descriptively. Level of neighborhood crime will be measured via an index of total crime derived from Uniform Crime Report data (CrimeRisk, Applied Geographic Solutions).
>
> *Physical activity locations.* GPS and accelerometry data will be matched in 15-sec epoch pairs based on date and time stamp, using the most recent version of SAS statistical software. GPS-ActiGraph GT3X+ matched data points will be compiled in global positioning systems software (ArcGIS 9.2) and combined with other spatial data (e.g., locations of parks, community centers). Project Consultants Dr. Brian Saelens and Dr. Philip Hurvitz of University of Washington are leading experts in the combination and interpretation of GPS-accelerometry matched data, and they will advise on data collection and the management and analysis of these combined data within the ArcGIS software (see letters of support). Participant PA locations will be categorized (e.g., park, school, home, other's home, etc.),[97] and the route distance between the PA location and the participant's home will also be calculated to facilitate distance-based categorization.

Neighborhood-level data

Neighborhood-level data will be collected from a variety of existing data sources. Measures will describe the neighborhood food environment, neighborhood physical activity facilities, and neighborhood physical and social disorder.

Physical activity opportunities. The procedures used to create measures of opportunities for physical activity closely follow those used by others.[47,98] A list of physical activity facilities (i.e., businesses associated with certain Standard Industrial Classification (SIC) codes will be compiled for zip codes associated with participant neighborhood buffers from a business list developed by ESRI. Opportunities for physical activity will be measured and examined as the number of available facilities, concentration of facilities (per neighborhood population), and facility density (per square mile).

Geocoding of address information. In the present study, accurate geocoding will depend mainly on the accuracy and completeness of the address information obtained from the environmental data files. Investigator Dr. Broyles has extensive experience in geocoding and will perform all address mapping. Further, Dr. Brian Saelens and Dr. Philip Hurvitz are subject matter experts in GPS data analysis and will act as consultants for this project (see letters of support).

Ecological momentary assessment app

EMA data will be collected using the participant's personal mobile device with a custom version of the EMA mobile application installed. The mobile application is compatible with iOS or Android powered devices. If the participant does not have or does not wish to use his/her own mobile phone, we will loan a mobile device with disabled voice and data services other than as required by the mobile application. The HIPAA-compliant mobile application will be programmed to display question sequences and response options on the mobile device screen, and de-identified data are encrypted and stored on the software platform's cloud-based storage database until downloaded by the investigator. Upon hearing the signal, children will be instructed to complete a short electronic survey taking approximately 2 to 3 minutes. The methodology, questions, and responses have been previously examined for validity, feasibility, and reliability by comparing time-matched accelerometer data to mobile phone-delivered EMA responses of activity type.[55,106] In a pilot focus group (n=8), children indicated that the device was easy to use and that they would be willing to participate in an EMA study in the future.[106] In a study of children ages 9 to 13 years (n=121), accelerometer counts of MVPA were significantly higher during EMA-reported physical activity than sedentary behaviors, independent of weight status ($p<0.0001$). Additionally, children responded to an average of 80% of EMA prompts.[106]

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
8 - 10am	X						X
10am - 12pm	X						X
12 - 2pm	X						X
2 - 4pm	X						X
4 - 6pm	X	X	X	X	X	X	X
6 - 8pm	X	X	X	X	X	X	X

Table 3. Sampling schedule for the EMA measurements.
Note. Question sequences are prompted at a random time within each interval.

We will use a signal-contingent sampling schedule that includes randomly delivered prompts including one prompt during each 2-hour window for a total of 2 prompts each weekday **(outside of school time)** and 6 prompts each weekend day (see **Table 3** for the EMA sampling schedule). Though the schedule will be standardized across participants, the schedule will vary each day within the time window, and the participant will not know the schedule ahead of time to prevent them from altering their behavior in anticipation of a prompt.

The participant will be asked a series of questions via the mobile application during each prompt. The questions have been previously validated on samples of children and adolescents using EMA.[55,56,59] The final ten questions are selected from the Positive and Negative Affect Schedule for Children.[107] See **Table 4** for questions that will be included in each EMA prompt.

What were you doing right before the beep went off?	Reading/computer/homework, watching tv/movies, playing video games, active play/sports/exercising, other
If other, what was this other activity?	Eating/drinking, talking/on the phone, chores, riding in a car, something else
Were you alone right before the beep went off?	Yes, No
If not alone, were you with your (parent, sibling, friend, etc.)	Mom or dad, brother(s) or sister(s), other family members (cousins, aunts, uncles), friend(s), classmates, people you don't know
Where were you just before the beep went off?	Home indoors, Home outdoors, School, Car/van/truck, Outdoors not at home, Restaurant, Store/mall, Someone else's house, Gym/rec center, Someplace else
How joyful / cheerful / happy / lively / proud / miserable / mad / afraid / scared / sad were you feeling just before the beep went off?	0-5 Likert scale

Table 4. Question prompts and answer choices for the EMA measurements.

Retention

We expect challenges in following up with this cohort 2 years after the Year 0 clinic visit. We will employ several retention strategies between Years 0 and 2 that have been successful in prior trials, including mailing birthday cards to child participants, sending quarterly newsletters on family and children's health topics, inviting families to the annual Pennington Biomedical 5K, and telephoning the parent 2 months prior to the Year 2 clinic visit to schedule the visit and answer questions. The child will receive a stipend after each completed clinic visit and upon returning the accelerometer/GPS tracker, and the child will receive a certificate of completion upon finishing the study. Additionally, Pennington Biomedical has an excellent retention rate for clinical trials. The population of Baton Rouge is relatively stable,[82] and the majority of children will still be enrolled in K-12 school. Offering assessments during summer and school holidays will increase the likelihood of participation. We successfully followed up with children in prior prospective trials: 87% of children aged 10 to 14 years returned for a 2-year follow-up clinic visit in our Baton Rouge Children's Study (114 of the initial 131).[77] Our retention for adult clinical trials is also excellent: we examined 14 trials conducted at Pennington Biomedical with a total of 1581 participants and observed a 70% retention rate over an average 4.8 year follow-up (range 1 year to 13 years). We expect an even higher retention rate due to the shorter follow-up time (2 years). Pennington Biomedical staff may contact participants every 3-6 months by phone or email to maintain contact between Year 0 and Year 2 clinic visits as well as schedule the Year 2 visit.

Anticipated Dropout

The 25% dropout rate is a combined estimate for both loss to follow-up and exclusions that occur during the clinic visit. Based on attrition at 2-year follow-up for Pennington Biomedical's Baton Rouge Children's Study,[77] 13% of the sample is expected to not report back for the 2-year follow up. An additional 12% is expected to be excluded due to exceeding weight limitations or the refusal of certain procedures (e.g. MRI, DXA) based on refusal rates in Pennington Biomedical's WAIST Study.[20]

Statistical Analysis

Objective 1:

The hypotheses will be tested using a series of generalized linear models with severe obesity as the independent variable. First, linear mixed effect models will be used to test for effects between BMIz and each dependent continuous variable (change in: min/day sedentary behavior, min/day MVPA, and each cardiometabolic risk factor). Next, logistic regression models will be used to determine the association between BMIz with the likelihood of not meeting recommended behaviors (i.e. top quartile of min/day of sedentary behavior; MVPA < 60 min/day) or being at elevated cardiometabolic risk. Finally, the cohort will be stratified into two groups based on obesity at Year 0: severely obese (SO) and not severely obese (NSO). Logistic regression models will be used to determine associations between SO (vs. NSO) and each dependent variable (i.e. change in: minutes/day sedentary time, minutes/day MVPA, and each continuous cardiometabolic risk factor). Covariates will include age, sex, dietary intake, and race. School

term vs. school holiday will be considered as an additional covariate if time of year is significantly associated with the independent and dependent variables.

Secondary analysis will use MRI and DXA as covariates in the model (namely the visceral, trunk, and total body fat). These measurements, along with BMIz, may be highly correlated. Various variable select criteria (including LASSO and support vector machine) will be used to determine which combination of these variables best explains the variance in the data. The full model will enable the comparison of imaging-based body composition measures vs. BMIz alone and their associations with physical activity, sedentary behavior, and cardiometabolic risk factors in children.

As exploratory analyses, dietary intake will be tested as a potential mediator to explain significant associations between the predictor variable (BMIz) on outcomes (physical activity, sedentary behavior, and cardiometabolic risk factors). Series of sequential models will be used to test each pathway using a path analysis model based on the Baron and Kenny causal steps for mediation.[73,74]

Objective 2:
Analyses to test Hypothesis 2 will be conducted using a series of linear regression models (i.e. linear mixed effects models). Based on difference score between Years 0 and 2 for total body fat, the group will be divided into two dichotomous groups using percentiles: high fat gainer (HFG) and low fat gainer (LFG). These variables will be used to predict changes in physical activity, sedentary behavior, and each cardiometabolic risk factor in linear mixed effect models. Covariates will include age, sex, dietary intake, and race. School term vs. school holiday will be considered as an additional covariate if time of year is significantly associated with the independent and dependent variables. Secondary analysis will use MRI and DXA as covariates in the model (namely the visceral, trunk, and total body fat). As previously reported, variable select criteria (including LASSO and support vector machine) will be used to determine which combination of these variables best explains the variance in the data. The full model will enable the comparison the accumulation of imaging-based body composition measures vs. BMIz alone and their associations with change in physical activity, sedentary behavior, and cardiometabolic risk factors in children. Finally, there are no standard accepted definitions of pediatric severe obesity to dichotomize participants based on MRI or DXA measures of body fat. Therefore, receiver operating characteristic curves will be created to estimate the value at which visceral, trunk, and body fat best correspond with the BMI definition of severe obesity (i.e. BMI $\geq$ 120% of the 95th percentile[1]). Clinically relevant cut-points of severe obesity based on total, trunk, and visceral body fat will be established among this diverse cohort of adolescents.

Power analysis

Objective 1:
The primary outcome for the first objective is change in minutes of sedentary behavior between Year 0 and Year 2 (i.e. Year 2 values minus Year 0 values). Baseline estimates for the two groups were calculated using the WAIST cohort data (from the 2010-11 assessment). Based on data from Berkey et al.,[75] the SO group is assumed to increase their sedentary time by 30 minutes/day at year 2, while smaller increases in sedentary time is expected for the NSO group (**Table 5**). A minimum of 334 participants is needed to ensure a well-powered study with significance level of $\alpha = 0.05$, 80% power to detect a 24 minute difference change in sedentary behavior between the two groups, and allowing for a dropout rate of 25%. Therefore, our sample size of up to 345 participants will be sufficient.

Change in minutes/day of sedentary time for NSO group	Change in minutes/day of sedentary time for SO group	Difference in change between groups	Standard deviation of change between groups	Minimum sample size	Total sample size (allows for 25% dropout)
2.4	30.0	27.6	69.6	202	253
3.6	30.0	26.4	69.6	222	278
4.8	30.0	25.2	69.6	242	303
6.0	**30.0**	**24.0**	**69.6**	**266**	**334**

Table 5. Difference in changes in sedentary time based on severe obesity status.
Note. NSO is the group classified as not severely obese; SO is the group classified as severely obese.

Secondary analyses will include change in daily MVPA minutes between years and change in days/week of physical activity (≥ 60 minutes MVPA/day) between years. Power analysis was conducted on these outcomes, using the WAIST cohort and data from Nigg et al.,[76] and our sample size will have power of 93.8% and 90.4% to detect a significant difference in change in daily MVPA minutes and change in days/week of physical activity, respectively.

Contingencies
Based on national reference data, it is possible that very few or no severely obese children meet the healthy behavior or cardiometabolic health criteria (e.g. no severely obese child attains ≥ 60 minutes of MVPA/day; no severely obese child has a waist circumference < 90th percentile). If this is the case, the dichotomous dependent variable will be adjusted to be quartiles, so that the analyses is interpreted as the likelihood of a severely obese child being in the top (healthiest) quartile of the health behavior or cardiometabolic health criteria for the overall cohort.

Objective 2:
The primary outcome for the second objective is the relationship between total fat accumulation and change in sedentary behavior. Based on data from Berkey et al.,[75] we estimate an overall change in sedentary behavior of 12 minutes/day increase in the HFG and 3.6 minutes/day increase in the LFG over a two-year period. **Table 6** shows sample sizes required to detect various differences for the change between groups. With a sample size of up to 345, this will provide at least 80% power for detecting a difference in the change between groups of 8.4 minutes/day, allowing for the anticipated 25% dropout. Therefore, with our sample size of up to 345 participants, we will have sufficient power to detect a difference between the HFG and LFG groups.

Change in minutes of sedentary time for HFG	Change in minutes of sedentary time for LFG	Change between groups	Standard deviation of change between groups	Minimum sample size	Total sample size (allows for 25% dropout)
12	2.4	9.6	24	194	259
12	3	9.0	24	220	293
12	**3.6**	**8.4**	**24**	**255**	**Up to 345**
12	4.2	7.8	24	292	389

Table 6. Difference in changes in sedentary time between the high fat vs. low fat gainer group.
Note. HFG is the group classified as high fat gainers; LFG is the group classified as low fat gainers.

Secondary analyses based on the second objective will include modeling the relationship between fat mass accumulation and change in physical activity. Using data from Berkey et al.,[75] we estimate an overall decrease of 19.2 minutes/day of MVPA in the HFG and a decrease of 4.8 minutes/day of MVPA in the LFG over a two-year period. With a sample size of up to 345 (including anticipated dropout), this will provide 93.4% power for detecting a difference in the change between groups of 14.4 minutes/day.

Contingencies

The DXA instrument has a maximal weight limit of 204 kg and the Signa Excite MRI has a maximal weight limit of 159 kg; therefore, no participants exceeding this weight will be allowed on the respective instrument. Furthermore, the MRI instrument has a maximal waist diameter limit of 60 cm with a 48 cm field of view. Based on the WAIST cohort, in which 4 of 423 participants exceeded weight limits, we anticipate that few participants for the present project will exceed the weight limits. However, we have accounted for 12% of the sample to exceed weight limits in thed sample, and we also have a contingency plan in place should this occur. The clinic coordinator will remove the DXA and/or MRI scan from the participant's schedule following the anthropometric measurement to minimize participant discomfort or embarrassment, and the anthropometric measures will be used to classify obesity status.

Objective 3:

Analyses to test the hypotheses will be conducted using linear models. The primary independent variable will be BMIz and the dependent variable will be physical activity (MVPA). The c statistic will be evaluated to assess the contributions of BMIz and the environmental (or socio-emotional) factors to increase the accuracy in model-based prediction of events using data collected at Year 0, Year 2, and the changes between Years 0 and 2. Linear models will also be used to examine if there are changes in environmental or socio-emotional factors between Years 0 and 2. Finally, severe obesity (vs. all others) will be tested as a dichotomous variable with each environmental or socio-emotional factor to determine associations with physical activity. School term vs. school holiday will be considered as an additional covariate if time of year is significantly associated with the independent and dependent variables.

For the models investigating environmental factors, the independent variables will include the family environment, park access and crime, perceived neighborhood environment, physical activity locations, and physical activity opportunities. Family environment subscales related to physical activity will initially be summed to create a single continuous score, with higher values indicating higher family support for physical activity. Additionally, the average minutes/day of MVPA will be summarized by location type. To examine socio-emotional factors, the independent variables will include body image, mood, and the data collected from the EMA including the three affect states (i.e. happy, stressed, energetic) and the social context of the activity (i.e. activity type and who was with the participant). For both the environmental and the socio-emotional factors, associations that are positively related to physical activity will be identified as facilitators of each, and inverse associations will be identified as barriers of each.

Contingencies

GPS and EMA are emerging technologies that have shown compliance and acceptability by children and adolescents.[106] However, we have considered the potential challenges that these devices present to participants and have created several contingency plans. EMA in particular may be perceived as burdensome and time-consuming since the participants receive several messages over several days.[57] Therefore, in the present project, children and their parents will receive an extensive introduction to the EMA technology and can request changes to the scheduled time interval to receive messages (e.g. if the child's bedtime is before 8 pm, the parents can request that messages end at the bedtime). In addition to stipends for completing the clinic visits, we also allocated $22 per participant to incentivize response to EMA queries, so the participant can earn $1 per finished survey. This incentive structure has been effective in prior EMA studies to encourage the participant to continue providing data.[106] We specifically designed questions that are short in length with few response options in order to minimize the time required of the participant. By limiting all EMA/GPS measures to 2 weeks (one week during Year 0 and one week during Year 2), interference to the participant's daily life is minimized.

We selected the EMA application over other EMA options due to its functionality and low cost. The EMA provides several strengths to maximize the collection of valid, reliable data:[57] reminder prompts are used for unanswered/unfinished entries in order to improve validity of the responses and minimize the

time lapse between response and activity; research staff members have real-time access to data to monitor compliance so they can immediately contact the participant by phone call or text message if a participant skips a survey response; questions employ skip sequences and branching to allow participants to skip questions that are not relevant; question sequence can be randomized to reduce participant boredom; participants are alerted via in-app push notifications, avoiding text messages that may incur an additional fee; and wireless internet connection is not required, so if the participant does not have access to wifi they will still receive prompts and answer the questions.

We will provide resources to participants to ensure that technical difficulties do not impede data collection (e.g. we will provide participants with a charger and regular reminders to charge the device to preserve power; we will provide a phone hotline and email address to provide technical assistance). It is possible that reactance may affect participants' responses, meaning that participants become more aware of behaviors, emotions, and cognitions as a result of being surveyed on a regular basis.[108,109] Therefore, we will not assess behavior-specific cognitions, and we limit the number of survey questions and the frequency of the prompts.

Despite our numerous efforts to maximize participant compliance, we anticipate a small amount of missing data from the accelerometer, GPS, and EMA measurements due to participants not completely complying with the protocol by either not wearing the devices for a sufficient period of time or not responding to EMA survey prompts. Multiple imputation has been shown to work well with this type of data[110] and will be used here. Sensitivity analysis will be conducted to determine if patterns exist in the missing data.

Data and Specimen Banking and Management

Blood samples will be banked for future research. These samples will be stored at Pennington Biomedical Research Center in a secure, locked storage freezer. Storage and disposal of biospecimens will be conducted in a manner conforming to the appropriate care and handling of biological specimens as outlined through the Institutional Biohazard Committee Guidelines. Only the investigators, study staff, and collaborators (including external to Pennington) explicitly given access to the samples by the principal investigator, will have access to these specimens.

Each participant will be issued an ID number that will be utilized throughout the study. A secure master file linking names, addresses and ID numbers will be maintained in a confidential computer file accessible only to the investigators. Access to data files can be made only with permission of the Principal Investigator. Privacy in the context of this study includes confidentiality of data and personal information. During interviews, measurements, and the study staff will ensure full privacy of participants and will ensure that the data are stored in a secured area. Hard copies of study data will be kept in a secure, locked cabinet at PBRC and electronic copies of study data will be kept in the secure PBRC and RedCap databases. All study staff must be HIPAA certified. Only de-identified data will be used for analysis.

PBRC's Data Management Core will be responsible for database design, database implementation, and manual data entry of clinic visit data. PBRC's Clinic Core will be responsible for managing clinic visit data using the REDCap secure, web-based database/survey application. PBRC's Biostatistics Core will cooperate with the data manager who will manage all data entry to ensure data quality.

Provisions to Monitor the Data to Ensure the Safety of Participants

This research requires slightly more than minimal risks to subjects due to the small radiation exposure in DXA and MRI, therefore does not warrant the establishment of an independent Data and Safety Monitoring Board (DSMB). This Data and Safety Monitoring plan describes the safety monitoring procedures for the proposed study, including a description of how often and to whom serious and unexpected adverse events will be reported. The plan will help ensure the safety of all participants. The PI

will communicate via electronic submission to the IRB all unanticipated problems as defined by the IRB and all serious adverse events (SAEs) to the medical investigator within 24 hours. All less serious adverse events will be reported to the medical investigator within 3 days of occurrence.
Subject Accrual and Compliance

1) Measurement and reporting of subject accrual, adherence to inclusion/exclusion criteria, protocol adherence, and rates of study completion – Review of subject accrual, adherence to inclusion/exclusion criteria and study procedures as listed in the protocol, and rates of study completion will occur monthly. These data will be reviewed by the study PI. The recruitment goals per month are listed in the table below.

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Month 13	Month 14	Month 15	Month 16	Month 17	Month 18	Month 19
	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
Overall Goal Total	10	30	50	70	90	110	125	140	155	175	195	220	245	270	290	310	320	330	340
Goal Monthly	10	20	20	20	20	20	15	15	15	20	20	25	25	25	20	20	10	10	10
Actual Monthly																			
Totals																			

Table 7. Recruitment goals per month

2) Stopping rules – Data on subject accrual and completion rates will be synthesized and evaluated yearly to determine if the study should be terminated. One of the most likely reasons for early termination is the failure to recruit or retain participants; therefore, these data will be evaluated yearly to determine if failure to recruit or attrition is jeopardizing the ability to empirically test the study aims.
3) AE rates and out of range laboratory data – AE rates will be evaluated quarterly and out of range laboratory data will be evaluated yearly by the study PI and Medical Investigator, to ensure proper AE reporting and to regulate procedures to protect participant safety.

Withdrawal of Participants

During the course of the study, participants may be withdrawn from the study for the following reasons:

- Unwillingness on behalf of the child or adolescent to participate in the study or cooperate with study staff
- Unwillingness on behalf of the parent or legally authorized representative to cooperate with study staff
- Presentation of significant medical symptoms that would warrant termination of study participation to protect the participant's safety
- Termination of the study by the sponsor

Data that have already been collected during the course of study participation from a withdrawn participant will be used, unless a specific request is otherwise received.

Risks to Participants

Blood sampling

There may be pain, light-headedness, infection, bleeding or bruising at the needle insertion site; however, aseptic (sterile) technique and trained personnel minimize these risks. The participant may feel hungry or weak during the time she is required to fast before the measurement. The amount of blood drawn is about 2 tablespoons. If the participant chooses to use the EMLA cream, the treated skin may temporarily block all sensations. The participant should avoid scratching, rubbing, or exposure to extreme hot or cold temperatures until complete sensation has returned. If the participant has a history of sensitivity to local anesthetics, we do not recommend that the child uses the EMLA cream.

There is a risk of loss of confidentiality and/or privacy associated with banking blood samples for future research. These blood samples may be given to other investigators for future research. The future research may occur at sites other than Pennington Biomedical Research Center and may be reviewed by other Institutional Review Boards when applicable. The research done with the specimens may help to develop new products in the future, or may be used to establish a cell line or test that could be patented or licensed. Participants will not receive any financial compensation for any patents, inventions or licenses developed from this research. Storage and disposal of biospecimens will be conducted in a manner conforming to the appropriate care and handling of biological specimens as outlined through the Institutional Biohazard Committee Guidelines.

Blood pressure

The participant may experience discomfort during blood pressure recordings due to the pressure of the cuff on their arm.

DXA Scan

The amount of radiation used during the whole-body dual energy x-ray absorptiometry scan is very small. The radiation dose for this scan is equivalent to the radiation you are naturally exposed to in the environment in less than one day. Scans will not be performed on any participant who is pregnant, and all females must submit to a urine pregnancy test prior to the scan.

MRI

There are no known biological risks associated with magnetic resonance scanning. It has been used routinely for over 20 years. It produces side effects in very few situations. Side effect description given to participants includes:

> **Metal**: Because the magnetic resonance machine uses a magnetic field, it can move any metallic objects that are inside the body. *This disruption of metal inside the body is extremely dangerous to you and may even be life threatening.* If you think you may have a cardiac stent, metallic implant, metallic piercings, shrapnel, or any other metallic material in your body, it is of utmost importance that you alert the study coordinator or MR technician. If you have metallic materials in your body that cannot be removed, we will exclude you from this study for your safety.
>
> **Electronics**: Magnetic resonance imaging involves the use of radio frequency energy that can disrupt the functioning of electronic devices. If you think you might possess a pacemaker or any other electronic medical device inside your body, it is of utmost importance that you inform the study coordinator or MR technician. If you have any such electronic devices we will exclude you from this study for your safety.
>
> **Tattoos and cosmetics**: Some tattoos and cosmetics contain metallic materials that can heat up during scanning, especially if they are located on the part of the body being scanned. If the metallic material heats up enough, you may feel an uncomfortable burning sensation, and a skin burn may develop. If you have any tattoos or cosmetics that might contain metallic materials, please alert the study coordinator or MR technician. If you feel a burning sensation on your skin, alert the study coordinator or MR technician. In some cases, the amount of metallic material in the area being scanned is so excessive that the scan must be stopped. In other cases, a cold compress placed over the metallic material will be used to prevent the burning sensation.
>
> **Confinement**: During the MR scan, you will be lying down on a table inside of a metal tube. The metal tube is a confined place. This might produce a feeling of claustrophobia, which can be distressing. If you have experienced claustrophobia in the past, you might become too distressed to complete the scan. If you become distressed during the scan due to confinement in the scanner tube, please alert the MR technician and the scan will be halted.

Noise: The MRI machine creates a loud, rhythmic noise that sounds like grinding or churning. This can be distressing to those who are sensitive to loud noises. You will be provided with earplugs to reduce the noise. But if you find the machine noises distressing, alert the MR technician and the scan can be halted.

Peripheral nerve stimulation: During the MR scan, the magnetic field around your body goes through rapid changes. These changes are all within safety limits set by the Food and Drug Administration. But, some people experience twitching in the nerves of their arms or legs as a result of these magnetic field changes. This twitching is generally not painful, and it stops at the end of the MR scan. But the feeling of inadvertent muscle twitching may make you feel disoriented or uncomfortable. If you experience this and wish to stop the scan as a result, please tell the MR technician.

Carbon dioxide: The level of carbon dioxide in the air during gas delivery experiments is similar to what you would find at high elevation. There is a slight risk that the carbon dioxide could lead to a mild headache or dizziness. If you experience this and wish to stop the scan as a result, please tell the MR technician.

Venous thromboembolism: In some elderly or obese individuals, lying down perfectly still for multiple hours can slightly increase the risk that blood clots develop in the blood vessels. These blood clots can be hazardous to your health. The technologist will make every effort to keep your time in the MRI machine as short as possible to reduce this risk. Also, you will have breaks during your time in the MRI machine, and during these breaks the technologist will ask you to move your arms and legs and reposition your body to get comfortable. Moving around in this way reduces your risk of blood clots.

Potential Benefits to Participants

No other benefits for participating in the TIGER study can be promised.

Vulnerable Populations

This study will involve children as participants (10-16 years of age). As such, their parents and/or legally authorized representative will have to provide written informed consent allowing their child to participate in the study. In addition, participating children will provide written assent.

All participants will be explicitly told that their participation is voluntary and that they may end (stop) their participation at any time. If a participant indicates that they wish to stop participating, all study procedures they are undertaking at that time will stopped to protect their rights and welfare.

Sharing of Results with Participants

Individual participant results will be provided if the participant or parent requests them. Results from the study will be submitted for manuscripts in scholarly journals and presentations. All study reports for publication will present only aggregated data to minimize the risks that a participant can be identified form their participation in the study.

Setting

Potential participants will be recruited utilizing the recruiting services (Recruitment Core) of the PBRC. All clinic visits will be performed at the PBRC in the Outpatient Clinic and/or the Translational Research Center for Children (TReCC).

Resources Available

Physical Resources

The Pennington Biomedical Research Center (PBRC) is a 187-acre campus of the Louisiana State University System located in Baton Rouge, Louisiana. The PBRC is a model for clinical and translational research, since it houses basic, clinical, and population research programs in one facility. PBRC houses 53 research laboratories, 19 core service laboratories, and more than $20 million in technologically advanced equipment. The following core units will support this project, operating as cost centers.

Outpatient clinic. The four-story Clinical Science Building (92,530 GSF) opened in 2010 and the adjoining Translational Research Clinic for Children (TReCC) opened in 2014. The outpatient clinic is overseen by Frank Greenway, M.D. All clinic visits will occur in these two facilities. A clinic coordinator will provide complete oversight of all clinical visits including scheduling visits, preparing medical charts, coordinating visits, reporting adverse events, and following up with participants. The clinic services include but are not limited to informed consent, anthropometry, vitals, blood draw, concomitant medication collection, adverse event assessment, telephone visits, questionnaires, and ordering/processing of participant stipends ($50 per clinic visit per participant disbursed as check or loadable debit card).

Data management and analysis. The PBRC Biostatistics and Data Management Core resides in the Population and Public Health Sciences program, headed by Peter Katzmarzyk, PhD (Investigator). The Biostatistics and Data Management Core is divided into two units: the Biostatistics Group and the Research Computing Group (RCG). Dr. William Johnson is directly responsible for overseeing the Biostatistics Group. In addition, Dr. Johnson supervises two other faculty biostatisticians (including Robbie Beyl, PhD, Collaborator), as well as several MS level biostatisticians. Further, Stephanie Broyles, PhD (Investigator) serves as an additional doctoral level biostatistician. Together, this team serves the research design and analysis needs for PBRC scientists. The Core is equipped with state-of-the art computers, and the E-mail and data transfer needs are supported by the PBRC Technology Services Group. The standard software used for statistical analysis is the most recent version of SAS, presently Version 9.4.

The Research Computing Group (RCG) is a unit within the department of Computing Services. RCG's primary responsibility is the continuing development of a proprietary web-based portal to the clinical research database. The clinical research database is a Microsoft SQL Server database secured on the Pennington Biomedical network. Direct access to this database is restricted to authorized personnel within the RCG and Computing Services. Security is managed by the Pennington Biomedical Computing Services Infrastructure Security Group and is administered in accordance with established standard operating procedures. Active Directory (AD) credentials serve to authenticate, authorize and facilitate accountability for a user's access to PBRC information systems. The RCG team interfaces with researchers to ensure the efficient and accurate transfer of data from observation to electronic files for storage and analysis; monitors the data processing throughout each study's duration; and provides investigators with study specific data sets via web-based desktop data access. The team has developed custom applications for expedited creation of study specific data sets that may contain both PBRC data and Non-PBRC data. This development and data storage paradigm allows the team to work with both intramural and extramural researchers.

Guidelines for Good Clinical Practices as they relate to data handling have been documented and implemented in daily tasks. The group maintains current HIPAA Security Rule training and works closely with the Director of Intellectual Property, Legal and Regulatory Affairs. Programmers are provided with the latest software and hardware which allow them to perform their work efficiently.

Clinical chemistry. The Clinical Research Laboratory is directed by Jennifer Rood, PhD, (Collaborator). Dr. Rood has initiated rigid quality control systems in the lab, and the laboratory is accredited by the Health Care Financing Administration (HCFA) and the College of American Pathologists (CAP). The

laboratory also participates in the lipid standardization program of the Centers for Disease Control and Prevention (CDC). The Clinical Research Laboratory is staffed by licensed medical technologists, phlebotomists, and accessioners. The laboratory is well-equipped for performing routine and specialized tests on clinical participants. In 2013 over 360 different analytical procedures were performed by the lab for a total of 300,000 assays. The major instrument housed at PBRC that will used on this project for assaying fasting glucose, triglycerides, and HDL cholesterol is the DXC600 manufactured by Beckman Coulter.

Imaging. The Imaging Center, directed by Owen Carmichael, PhD (Collaborator) is a new 30,000 square foot two-story Imaging Center that is connected to the clinic and to the Clinical Research Building and opened in 2013. The Core personnel currently includes 3 licensed radiological technologists (an MR technologist, a CT technologist/Image analyst, and a DXA technologist), an ultrasound technologist, an engineer (M.S.) for the optical spectrometer, and a Baton Rouge Radiology Group serves as a consultant for interpretation of scans as needed. The Imaging Core will provide acquisition and analysis services for the DXA and MRI scans.

Recruiting/Advertising. The Recruiting Core is composed of 3 full-time recruiters, 3 to 6 part-time recruiters, an outreach coordinator, and a full-time manager who coordinates advertising. The department receives 3200 calls and 829 complete web screenings per month from potential volunteers that are facilitated by a Uniform Call Distributor system and online survey. The online screening survey established in 2013 provides an additional outlet for parents to register their children for studies. Monies are allocated to produce brochures, purchase advertisements, conduct active recruiting efforts including online marketing and at other venues, and phone screen participants for the study.

Supplies. Monies are allocated to purchase GPS devices, accelerometers, and mobile devices (for those children who do not have a mobile device or do not wish to use theirs for the purposes of the study), as well as the contracted usage of the EMA software.

Human Resources
There are currently 64 full-time faculty members at PBRC, in addition to several hundred post-doctoral fellows and other research staff.

Investigators. This project is led by Amanda Staiano, PhD (0.30 FTE; developmental psychology) and team members Peter Katzmarzyk, PhD (0.15 FTE; physical activity epidemiology), Robert Newton, PhD (0.20 FTE; physical activity and ethnic minority health), Stephanie Broyles, PhD (0.20 FTE; contextual risk factors), and Catherine Champagne, PhD (0.10 FTE; nutritional epidemiology). Specific roles are detailed in the Project Management and Evaluation section.

Collaborators. Several collaborators among the Pennington Biomedical faculty have been identified (see letters of support). Robbie Beyl, PhD, 0.05 FTE, is an Assistant Professor of Biostatistics and will conduct all of the statistical analysis for the project. Daniel Hsia, MD, is an Assistant Professor, a pediatrician and an internist, and board certified in adult and pediatric endocrinology. Dr. Hsia will review participants' risk factor profiles and refer abnormal values to appropriate medical care. Jennifer Rood, PhD, is Professor and Associate Executive Director for Cores and Resources, and she will supervise the collection of blood and analysis of all clinical chemistry assays. Owen Carmichael, PhD, is Associate Professor and Director of the Biomedical Imaging Center and will supervise the acquisition and analysis of the DXA and MRI scans. Corby Martin, PhD, is Associate Professor and Director of the Ingestive Behavior Laboratory and will supervise the contract with the EMA vendor, will contribute to the manual of procedures for the EMA measures, and will contribute to the analysis and interpretation of results. Tiffany Stewart, PhD, is Associate Professor and Director of the Behavior Technology Laboratory on Eating Disorders and Obesity, and she will supervise the analysis and interpretation of the socio-emotional instruments especially the body image, mood, and affect assessments.

Technical support staff. In addition, several support personnel are available for the project. A project manager will provide overall project coordination. Research specialists will coordinate accelerometry, EMA, and GPS data collection. Two external consultants (Brian Saelens, PhD, Seattle Children's Hospital and University of Washington; Philip Hurvitz, PhD, Northwest Geospatial, LLC) will provide consultation for the management and analysis of the GPS data.

Compensation

The child will receive a $25 stipend after each completed clinic visit. In addition to stipends for completing the clinic visits, we also allocated $25 per participant to incentivize response to EMA queries as well as wearing and returning the accelerometer/GPS trackers. The total possible compensation received per participant will be $100. The child will also receive a certificate of completion upon finishing the study. Participants that are offered the COVID-19 survey will be eligible for a $20 stipend upon completion of the survey.

Confidentiality

All data collected in this project will be subject to the same confidentiality requirements that are in place for other studies at the PBRC. Study files will be kept in locked cabinets and access restricted to study staff. All PBRC staff sign a confidentiality statement. Personal identifiers are not included in computer files. No individual's data will be released without their specific written consent.

Provisions to Protect the Privacy Interests of Participants

Privacy in the context of this study includes confidentiality of data and personal information. During interviews, measurements, and intervention, the study staff will ensure full privacy of participants and will ensure that the data are stored in a secured area. Clinic measurements will be conducted individually in private, with only the clinic assessor, the participant, and the participant's parent/legal guardian to protect the privacy interests of the participant.

Compensation for Research-Related Injury

No form of compensation for medical treatment or for other damages (i.e., lost wages, time lost from work, etc.) will be available for this research study. In the event of injury or medical illness resulting from the research procedures, participants will be referred to a treatment facility.

Economic Burden to Participants

Participants and their parent/legal guardian will be required to bear the cost of transportation to and from PBRC for clinic visits. Due to the design of this study, the burden associated with travel is low, with participants only attending 2 visits at PBRC over a 2-year span.

Consent Process

Informed consent will be obtained from the parent/legal guardian and assent will be obtained from the child by PBRC clinic staff prior to conducting any study procedures. Because there is not a greater than minimal risk, informed consent will be obtained from one parent even if the other parent is alive, known, competent, reasonably available, and shares legal responsibility for the care and custody of the child.

Written informed consent and assent will be collected in a private room of the Outpatient Clinic or TReCC during the screening visit. The study procedures will be explained to parent and prospective participant (10-16 years of age). Both will be asked if they have any questions about the study and will be given adequate time to review and ask questions. The parent/legally authorized representative will be given an informed consent form to read and sign indicating their permission to allow their child to participate in the study. Following the obtainment of written parental consent, participants 10-16 years of age will be given a written assent form to read and sign before participating in any study procedures. The study staff member administering consent may read the assent to the participant if requested, or if the participant has a low literacy level.

References

1. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the united states, 2011-2012. *JAMA.* 2014;311(8):806-814.
2. Mirnezami R, Nicholson J, Darzi A. Preparing for precision medicine. *New Engl J Med.* 2012;366(6):489-491.
3. Khoury MJ, Gwinn ML, Glasgow RE, Kramer BS. A population approach to precision medicine. *Am J Prev Med.* 2012;42(6):639-645.
4. U.S. Department of Agriculture. Scientific Report of the 2015 Dietary Guidelines Advisory Committee. 2015.
5. Lobelo F, Stoutenberg M, Hutber A. The Exercise is Medicine Global Health Initiative: a 2014 update. *Br J Sports Med.* 2014;48(22):1627-1633.
6. Harrington DM, Champagne CM, Broyles ST, Johnson WD, Tudor-Locke C, Katzmarzyk PT. Steps ahead: A randomized trial to reduce unhealthy weight gain in the lower Mississippi delta. *Obesity.* 2014;22(5):E21-E28.
7. Skelton JA, Cook SR, Auinger P, Klein JD, Barlow SE. Prevalence and trends of severe obesity among US children and adolescents. *Acad Pediatr.* 2009;9(5):322-329.
8. US Preventive Sercies Task Force. Screening for obesity in children and adolescents: US Preventive Services Task Force recommendation statement. *Pediatrics.* 2010;125(2):361.
9. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc.* 2008;40(1):181-188.
10. Carson V, Staiano A, Katzmarzyk P. Physical activity, screen time, and sitting among US adolescents. *Pediatric Exercise Science.* 2015;27(1):151-9.
11. Skelton JA, Beech BM. Attrition in paediatric weight management: a review of the literature and new directions. *Obesity Reviews.* 2011;12(5):e273-e281.
12. Barlow SE, Ohlemeyer CL. Parent reasons for nonreturn to a pediatric weight management program. *Clin Pediatr (Phila).* 2006;45(4):355-360.
13. Kitscha CE, Brunet K, Farmer A, Mager DR. Reasons for non-return to a pediatric weight management program. *Can J Diet Pract Res.* 2009;70(2):89-94.
14. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007-2008. *JAMA.* 2010;303(3):242-249.
15. Kelly AS, Barlow SE, Rao G, Inge TH, Hayman LL, Steinberger J, Urbina EM, Ewing LJ, Daniels SR. Severe obesity in children and adolescents: identification, associated health risks, and treatment approaches: a scientific statement from the American Heart Association. *Circulation.* 2013;128(15):1689-1712.

16. Staiano AE, Broyles ST, Gupta AK, Katzmarzyk PT. Ethnic and sex differences in visceral, subcutaneous, and total body fat in children and adolescents. *Obesity (Silver Spring).* 2013;21(6):1251-1255.
17. Staiano AE, DM Harrington, ST Broyles, AK Gupta and PT Katzmarzyk. Television, adiposity, and cardiometabolic risk in children and adolescents. *American Journal of Preventive Medicine* 2013;44(1):40-7.
18. Staiano AE, AK Gupta, PT Katzmarzyk. Cardiometabolic risk factors and fat distribution in children and adolescents. *Journal of Pediatrics* 2014;164(3):560-5.
19. Broyles ST, AE Staiano, KT Drazba, AK Gupta, M Sothern, PT Katzmarzyk. Elevated C-reactive protein in children from risky neighborhoods: Evidence for a stress pathway linking neighborhoods and inflammation in children. *PLoS ONE* 2012;7(9): e45419. 20. Staiano AE, Broyles ST, Gupta AK, Katzmarzyk PT. Ethnic and sex differences in visceral, subcutaneous, and total body fat in children and adolescents. *Obesity.* 2013;21(6):1251-5.
21. Staiano AE, ST Broyles, AK Gupta, RM Malina, PT Katzmarzyk. Maturity-associated variation in total and depot-specific body fat in children and adolescents. *American Journal of Human Biology.* 2013;25(4):473-9.
22. Harrington DM, AE Staiano, ST Broyles, AK Gupta, PT Katzmarzyk. BMI percentiles for the identification of abdominal obesity and metabolic risk in children and adolescents: Evidence in support of the CDC 95th percentile. *European Journal of Clinical Nutrition.* 2013;67(2):218-22.
23. Harrington DM, AE Staiano, ST Broyles, AK Gupta, PT Katzmarzyk. Waist circumference measurement site does not affect relationships with visceral adiposity and cardiometabolic risk factors in children. *Pediatric Obesity* 2013;8(3):199-206.
24. Johnston CA, Tyler C, Palcic JL, Stansberry SA, Gallagher MR, Foreyt JP. Smaller weight changes in standardized body mass index in response to treatment as weight classification increases. *J Ped.* 2011;158(4):624-627.
25. Kalarchian MA, Levine MD, Arslanian SA, Ewing LJ, Houck PR, Cheng Y, Ringham RM, Sheets CA, Marcus MD. Family-based treatment of severe pediatric obesity: Randomized, controlled trial. *Pediatrics.* 2009;124(4):1060-1068.
26. Levine MD, Ringham RM, Kalarchian MA, Wisniewski L, Marcus MD. Is family-based behavioral weight control appropriate for severe pediatric obesity? *Int J Eating Dis.* 2001;30(3):318-328.
27. Savoye M, Shaw M, Dziura J, Tamborlane WV, Rose P, Guandalini C, Goldberg-Gell R, Burgert TS, Cali AM, Weiss R, Caprio S. Effects of a weight management program on body composition and metabolic parameters in overweight children: a randomized controlled trial. *JAMA.* 2007;297(24):2697-2704.
28. Savoye M, Nowicka P, Shaw M, Yu S, Dziura J, Chavent G, O'Malley G, Serrechia JB, Tamborlane WV, Caprio S. Long-term results of an obesity program in an ethnically diverse pediatric population. *Pediatrics.* 2011;127(3):402-410.
29. Shen W, Wang Z, Punyanita M, Lei J, Sinav A, Kral JG, Imielinska C, Ross R, Heymsfield S. Adipose tissue quantification by imaging methods: A proposed classification. *Obesity.* 2003;11(1):5-16.
30. Staiano AE, Katzmarzyk PT. Ethnic and sex differences in body fat and visceral and subcutaneous adiposity in children and adolescents. *Int J Obes Relat Metab Disord.* 2012;36(10):1261-1269.
31. Must A, Tybor DJ. Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. *Int J Obes Relat Metab Disord.* 2005;29(S2):S84-S96.
32. Sirard JR, Pate RR. Physical activity assessment in children and adolescents. *Sports Medicine.* 2001;31(6):439-454.
33. Newton Jr RL, Han H, Zderic T, Hamilton M. The energy expenditure of sedentary behavior: a whole room calorimeter study. *PLoS One.* 2013;8(5):e63171.
34. Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC, Goldfield G, Gorber SC. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act.* 2011;8:98.

35. Chaput JP, Leduc G, Boyer C, Belanger P, LeBlanc AG, Borghese MM, Tremblay MS. Objectively measured physical activity, sedentary time and sleep duration: independent and combined associations with adiposity in canadian children. *Nutr Diabetes.* 2014;4:e117.
36. Roger VL, Go AS, Lloyd-Jones DM, Benjamin EJ, Berry JD, Borden WB, Bravata DM, Dai S, Ford ES, Fox CS, Fullerton HJ, Gillespie C, Hailpern SM, Heit JA, Howard VJ, Kissela BM, Kittner SJ, Lackland DT, Lichtman JH, Lisabeth LD, Makuc DM, Marcus GM, Marelli A, Matchar DB, Moy CS, Mozaffarian D, Mussolino ME, Nichol G, Paynter NP, Soliman EZ, Sorlie PD, Sotoodehnia N, Turan TN, Virani SS, Wong ND, Woo D, Turner MB. Heart disease and stroke statistics--2012 update: a report from the American Heart Association. *Circulation.* 2012;125(1):e2-e220.
37. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity in the United States, 2009-2010. *NCHS Data Brief.* 2012(82):1-8.
38. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *JAMA* 2012;307(5):491-497.
39. Kochanek KD, Arias E, Anderson RN. How did cause of death contribute to racial differences in life expectancy in the United States in 2010? *NCHS Data Brief.* 2013(125):1-8.
40. Harper S, Rushani D, Kaufman JS. Trends in the black-white life expectancy gap, 2003-2008. *JAMA* 2012;307(21):2257-2259.
41. Do DP, Finch BK, Basurto-Davila R, Bird C, Escarce J, Lurie N. Does place explain racial health disparities? Quantifying the contribution of residential context to the Black/white health gap in the United States. *Soc Sci Med.* 2008;67(8):1258-1268.
42. Braveman P. A health disparities perspective on obesity research. *Prev Chronic Dis.* 2009;6(3):A90.
43. Kelly CM, Schootman M, Baker EA, Barnidge EK, Lemes A. The association of sidewalk walkability and physical disorder with area-level race and poverty. *J Epidemiol Commun Health.* 2007;61(11):978-983.
44. Brownson RC, Baker EA, Housemann RA, Brennan LK, Bacak SJ. Environmental and Policy Determinants of Physical Activity in the United States. *Am J Public Health.* 2001;91(12):1995-2003.
45. Wilson DK, Kirtland KA, Ainsworth BE, Addy CL. Socioeconomic status and perceptions of access and safety for physical activity. *Ann Behav Med.* 2004;28(1):20-28.
46. Franzini L, Taylor W, Elliott MN, Cuccaro P, Tortolero SR, Gilliland MJ, Grunbaum J, Schuster MA. Neighborhood characteristics favorable to outdoor physical activity: disparities by socioeconomic and racial/ethnic composition. *Health Place.* 2010;16(2):267-274.
47. Gordon-Larsen P, Nelson MC, Page P, Popkin BM. Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics.* 2006;117(2):417-424.
48. Estabrooks PA, Lee RE, Gyurcsik NC. Resources for physical activity participation: does availability and accessibility differ by neighborhood socioeconomic status? *Ann Behav Med.* 2003;25(2):100-104.
49. Moore LV, Diez Roux AV, Evenson KR, McGinn AP, Brines SJ. Availability of recreational resources in minority and low socioeconomic status areas. *Am J Prev Med.* 2008;34(1):16-22.
50. Niederdeppe J, Bu QL, Borah P, Kindig DA, Robert SA. Message design strategies to raise public awareness of social determinants of health and population health disparities. *Milbank Q.* 2008;86(3):481-513.
51. Lee RE, Cubbin C. Striding toward social justice: the ecologic milieu of physical activity. *Exerc Sport Sci Rev.* 2009;37(1):10-17.
52. Stroup DF, Johnson V, Hahn RS, Proctor DC. Reversing the trend of childhood obesity. *Prev Chronic Dis.* 2009;6(3):A83.
53. Epstein LH, Raja S, Gold SS, Paluch RA, Pak Y, Roemmich JN. Reducing sedentary behavior: The relationship between park area and the physical activity of youth. *Psychological Science.* 2006;17(8):654-659. 54. Newton Jr LR, Marker MA, Allen RH, Machtmes R, Han H, Johnson WD, Schuna JM Jr, Broyles ST, Tudor-Locke C, Church TS. Parent-targeted mobile phone intervention to increase physical activity in sedentary children: Randomized pilot trial. *JMIR mHealth uHealth.* 2014;2(4):e48.
55. Dunton GF, Whalen CK, Jamner LD, Henker B, Floro JN. Using ecologic momentary assessment to measure physical activity during adolescence. *Am J Prev Med.* 2005;29(4):281-287.

56. Dunton GF, Kawabata K, Intille S, Wolch J, Pentz MA. Assessing the social and physical contexts of children's leisure-time physical activity: an ecological momentary assessment study. *Am J Health Prom.* 2012;26(3):135-142.
57. Marszalek J, Morgulec-Adamowicz N, Rutkowska I, Kosmol A. Using ecological momentary assessment to evaluate current physical activity. *BioMed Research International.* 2014;2014:915172.
58. Dunton GF, Intille SS, Wolch J, Pentz MA. Children's perceptions of physical activity environments captured through ecological momentary assessment: a validation study. *Preventive medicine.* 2012;55(2):119-121.
59. Dunton GF, Huh J, Leventhal AM, Riggs N, Hedeker D, Spruijt-Metz D, Pentz MA. Momentary assessment of affect, physical feeling states, and physical activity in children. *Health Psych.* 2014;33(3):255.
60. Staiano AE, Broyles ST, Katzmarzyk PT. School term vs. school holiday: Associations with children's physical activity, screen-time, diet and sleep. *Int J Environ Res Public Health.* 2015;12(8):8861-8870.
61. Centers for Disease Control and Prevention. A SAS program for the CDC growth charts. 2011; http://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm. Accessed January 30, 2015.
62. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents. *Pediatrics.* 2004;114(Suppl 2):555-576.
63. National Heart Blood and Lung Institute. *Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents*: US Department of Health and Human Services and the National Institutes of Health;2011.
64. Trost SG, Pate RR, Freedson PS, Sallis JF, Taylor WC. Using objective physical activity measures with youth: How many days of monitoring are needed? *Med Sci Sports Exerc*. 2000;32:426-31.
65. Barreira TV, Schuna JM Jr, Mire EF, Katzmarzyk PT, Chaput JP, Leduc G, Tudor-Locke C. Identifying children's nocturnal sleep using 24-h waist accelerometry. *Med Sci Sports Exerc*. 2015;47:937-43.
66. Tudor-Locke C, Barreira TV, Schuna JM Jr, Mire EF, Katzmarzyk PT. Fully automated waist-worn accelerometer algorithm for detecting children's sleep-period time separate from 24-h physical activity or sedentary behaviors. *Appl Physiol Nutr Metab*. 2014;39:53-7.
67. Tudor-Locke C, Camhi SM, Troiano RP. A catalog of rules, variables, and definitions applied to accelerometer data in the Natonal Health and Nutrition Examination Survey, 2003-2006. *Preventing Chronic Disease*. 2012;9:110332.
68. Evenson KR, Catellier DJ, Gill K, Ondrak KS, McMurray RG. Calibration of two objective measures of physical activity for children. *J Sports Sci.* 2008;26(14):1557-1565.
69. McPherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK. Dietary assessment methods among school-aged children: Validity and reliability. *Prev Med*. 2000;31(2):S11–S33. 70. Subar A, Mittl B, Zimmerman T, Kirkpatrick S, Schap T, Wilson M, Potischman N. Use of the automated self-administered 24-hour recall (ASA24) in the real world. *The FASEB Journal.* 2015;29(1).
71. Kirkpatrick SI, Subar AF, Douglass D, Zimmerman TP, Thompson FE, Kahle LL, George SM, Dodd KW, Potischman N. Performance of the automated self-administered 24-hour recall relative to a measure of true intakes and to an interviewer-administered 24-h recall. *Am J Clin Nutr*. 2014;100(1):233-240.
72. Baranowski T, Islam N, Baranowski J, Martin S, Beltran A, Dadabhoy H, Adame S, Watson KB, Thompson D, Cullen KW, Subar A. Comparison of a web-based versus traditional diet recall among children. *J Acad Nutr Diet.* 2012;112(4):527-532.
73. Kraemer HC, Kiernan M, Essex M, Kupfer DJ. How and why criteria defining moderators and mediators differ between the Baron & Kenny and MacArthur approaches. *Health Psychol* 2008;27(2 Suppl):S101-108.
74. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol* 1986;51(6):1173-1182.

75. Berkey CS, Rockett HR, Gillman MW, Colditz GA. One-year changes in activity and in inactivity among 10-to 15-year-old boys and girls: relationship to change in body mass index. *Pediatrics.* 2003;111(4):836-843.
76. Nigg CR, Amato K. The influence of health behaviors during childhood on adolescent health behaviors, health indicators, and academic outcomes among participants from Hawaii. *Int J Behav Med.* 2015;22(4):452-60.
77. Bray GA, DeLany JP, Harsha DW, Volaufova J, Champagne CM. Body composition of african american and white children: a 2-year follow-up of the baroc study. *Obes Res.* 2001;9(10):605-621.
78. Newton RL, Jr., Han H, Anton SD, Martin CK, Stewart TM, Lewis L, Champagne CM, Sothern M, Ryan D, Williamson DA. An environmental intervention to prevent excess weight gain in African-American students: a pilot study. *Am J Health Promot.* 2010;24(5):340-343.
79. Williamson DA, Copeland AL, Anton SD, Champagne C, Han H, Lewis L, Martin C, Newton RL Jr, Sothern M, Stewart T, Ryan D. Wise Mind project: a school-based environmental approach for preventing weight gain in children. *Obesity.* 2007;15(4):906-917.
80. Staiano AE, Abraham AA, Calvert SL. The Wii Club: Gaming for Weight Loss in Overweight and Obese Youth. *Games for Health: Research, Development, and Clinical Applications.* 2012;1(5):377-380.
81. Flynn RM, Richert RA, Staiano AE, Wartella E, Calvert SL. Effects of exergame play on executive functioning in children and adolescents at a summer camp for low income youth. *J Educ Develop Psychol.* 2014;4(1):209-225.
82. U.S. Census Bureau. American FactFinder, 2014. *Available at: http://factfinder.census.gov.* Accessed November 15, 2014.
83. Aguilar DP, Barbeau SJ, Labrador MA, Perez AJ, Perez RA, Winters PL. Quantifying position accuracy of multimodal data from global positioning system-enabled cell phones. *Transport Res Record.* 2007;1992:54-60.
84. Wolf J. Application of new technologies in travel surveys. In: Stopher P, Stecher C, eds. *Travel survey methods: Quality and future directions.* San Francisco, CA: Elsevier; 2006.
85. Cho GH, Rodriguez DA, Evenson KR. Identifying Walking Trips Using GPS Data. *Med Sci Sports Exerc.* 2011;43(2):365-372. 86. Kang B, Moudon AV, Hurvitz PM, Reichley L, Saelens BE. Walking objectively measured: classifying accelerometer data with GPS and travel diaries. *Med Sci Sports Exerc.* 2013;45(7):1419-1428.
87. Sallis JF, Taylor WC, Dowda M, Freedson PS, Pate RR. Correlates of vigorous physical actvity for children in grades 1 through 12: comparing parent-reported and objectively measured physical activity. *Pediatr Exerc Sci.* 2002;14:30-44.
88. Norman GJ, Schmid BA, Sallis JF, Calfas KJ, Patrick K. Psychosocial and environmental correlates of adolescent sedentary behaviors. *Pediatrics.* 2005;116(4):908-916.
89. Salmon J, Timperio A, Telford A, Carver A, Crawford D. Association of family environment with children's television viewing and with low level of physical activity. *Obes Res.* 2005;13(11):1939-1951.
90. Kohl HW, Blair SN, Paffenbarger RS, Jr., Macera CA, Kronenfeld JJ. A mail survey of physical activity habits as related to measured physical fitness. *Am J Epidemiol.* 1988;127(6):1228-1239.
91. Saelens BE, Sallis JF, Frank LD, Couch SC, Zhou C, Colburn T, Cain KL, Chapman J, Glanz K. Obesogenic neighborhood environments, child and parent obesity: the Neighborhood Impact on Kids study. *Am J Prev Med.* 2012;42(5):e57-64.
92. Coloabianchi N, Coulton CJ, Hibbert JD, McClure SM, Ievers-Landis CE, Davis EM. Adolescent self-defined neighborhoods and activity spaces: spatial overlap and relations to physical activity and obesity. *Health & Place*. 2014;27:22-29.
93. Frank LD, Saelens BE, Chapman J, Sallis JF, Kerr J, Glanz K, Couch SC, Learnihan V, Zhou C, Colburn T, Cain KL. Objective assessment of obesogenic environments in youth: Geographic Information System methods and spatial findings from the Neighborhood Impact on Kids study. *Am J Prev Med.* 2012;42(5):e47-55.
94. Daniel M, Moore S, Kestens Y. Framing the biosocial pathways underlying associations between place and cardiometabolic disease. *Health Place.* 2008;14(2):117-132.

95. Katzmarzyk PT, Barreira TV, Broyles ST, Champagne CM, Chaput JP, Fogelholm M, Hu G, Johnson WD, Kuriyan R, Kurpad A, Lambert EV, Maher C, Maia J, Matsudo V, Olds T, Onywera V, Sarmiento OL, Standage M, Tremblay MS, Tudor-Locke C, Zhao P, Church TS. The International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE): design and methods. *BMC Public Health.* 2013;13:900.
96. Hume C, Salmon J, Ball K. Associations of children's perceived neighborhood environment with walking and physical activity. *American Journal of Health Promotion.* 2007; 21:201-207.
97. Giles-Corti B, Donovan RJ. The relative influence of individual, social and physical environment determinants of physical activity. *Soc Sci Med.* 2002;54(12):1793-1812.
98. Kneeshaw-Price S, Saelens BE, Sallis JF, Glanz K, Frank LD, Kerr J, Hannon PA, Grembowski DE, Chan K CG, Cain KL. Children's objective physical activity by location: why the neighborhood matters. *Pediatr Exerc Sci.* 2013;25(3):468-486.
99. Veron-Guidry S, Williamson DA. Development of a body image assessment procedure for children and preadolescents. *Int J Eating Disord.* 1996;20(3):287-293.
100. Truby H, Paxton SJ. Development of the children's body image scale. *British J Clin Psychol.* 2002;41(2):185-203.
101. Kovacs M. The Children's Depression, Inventory (CDI). *Psychopharmacol.Bull.* 1985;21(4):995-998.
102. Neumark-Stzainer D, Paxton SJ, Hannan PJ, Haines J, & Story M. Does body satisfaction matter? Five-year longitudinal associations between body satisfaction and health behaviors in adolescent females and males. *Journal of Adolescent Health.* 2006;39:244-251. 103. Goldfield GS, Moore C, Henderson K, Buhholz A, Obeid N, & Flament M.F. Body dissatisfaction, dietary restraint, depression, and weight status in adolescents. *Journal of School Health.* 2010;80(4):186-192.
104. Schiefelbien EL, Mirchandani GG, George GC, Becker EA, Castrucci BC, & Hoelsher DM. Association between depressed mood and perceived weight in middle and high school age students: Texas 2004-2005. *Maternal and Child Health Journal.* 2012;16:169-176.
105. Jeffery AN, Hyland ME, Hosking J, & Wilkin TJ. Mood and its association with metabolic health in adolescents: a longitudinal study, EarlyBird 65. *Pediatric Diabetes.* 2014;15:599-605.
106. Dunton GF, Liao Y, Intille SS, Spruijt-Metz D, Pentz M. Investigating children's physical activity and sedentary behavior using ecological momentary assessment with mobile phones. *Obesity.* 2011;19(6):1205-1212.
107. Ebesutani C, Regan J, Smith A, Reise S, Higa-McMillan C, Chorpita BF. The 10-Item Positive and Negative Affect Schedule for Children, Child and Parent Shortened Versions: Application of Item Response Theory for More Efficient Assessment. *J Physcopathol Behav Assess.* 2012; 34:191-203.
108. Levav J, Fitzsimons GJ. When questions change behavior: The role of ease of representation. *Psychol Sci.* 2006;17(3):207-213.
109. Rowan PJ, Cofta-Woerpel L, Mazas CA,Vidrine JI, Reitzel LR, Cinciripini PM, Wetter DW. Evaluating reactivity to ecological momentary assessment during smoking cessation. *Exp Clin Psychopharm.* 2007;15(4):382.
110. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, Wood AM, Carpenter JR. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ.* 2009;338:b2393.
111. Tudor-Locke C, Camhi SM, Leonardi C, Johnson WD, Katzmarzyk PT, Earnest CP, Church TS. Patterns of adult stepping cadence in the 2005–2006 NHANES. *Prev Med.* 2011;53(3):178-181.
112. Harrington DM, Tudor-Locke C, Champagne CM, Broyles ST, Harsha DW, Kennedy BM, Johnson WD, Allen R, Katzmarzyk PT. Step-based translation of physical activity guidelines in the Lower Mississippi Delta. *Appl Physiol Nutr Metab.* 2011;36(4):583-585.
113. Katzmarzyk PT, Champagne CM, Tudor-Locke C, Broyles ST, Harsha D, Kennedy BM, Johnson WD. A short-term physical activity randomized trial in the Lower Mississippi Delta. *PLoS One.* 2011;6(10):e26667.

114. Harrington DM, Champagne CM, Broyles ST, Johnson WD, Tudor-Locke C, Katzmarzyk PT. Cardiometabolic risk factor response to a lifestyle intervention: A randomized trial. *Metab Syn Relat Disord* 2015;13:125-131.
115. Ravens-Sieberer, U., Gosch, A., Rajmil, L., Erhart, M., Bruil, J., Duer, W., Auquier, P., Power, M., Abel, T., Czemy, L., Mazur, J., Czimbalmos, A., Tountas, Y., Hagquist, C., Kilroe, J. and the European KIDSCREEN Group. (2005). KIDSCREEN-52 quality-of-life measure for children and adolescents. Expert Review of Pharmacoeconomics & Outcomes Research, 5 (3), 353-364.
116. The KIDSCREEN Group Europe. (2006). The KIDSCREEN Questionnaires - Quality of life questionnaires for children and adolescents. Handbook. Lengerich: Pabst Science Publishers.
117. Sharp C, Goodyer IM, Croudace TJ. The short mood and feelings questionnaire (SMFQ): a unidimensional item response theory and categorical data factor analysis of self-report ratings from a community sample of 7-through 11-year-old children. J Abnorm Child Psychol 2006;34:379-91.
118. Campbell-Sills L & Stein MB. Psychometric analysis and refinement of the Connor-Davidson Resilience Scale (CD-RISC): Validation of a 10-item measure of resilience. J Trauma Stress 2007;20(6):1019-28.
119. Carter A, Timperio A, Hesketh K, Crawford D. Are children and adolescents less active if parents restrict their physical activity and active transport due to perceived risk? J Social Science and Medicine 2010: 70: 1799-1805.