The Healthy Growth Study: Findings from Year Four

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Abstract

Objectives: For African American girls, the research questions were: 1) Do body fat, maturity, and physical activity predict blood pressure values? 2) Do body fat, maturity, and psychosocial and environmental variables predict physical activity? 3) Do maturity and physical activity predict body fat? *Methods:* The design was a four year observational study and measures were taken twice a year. The anthropometric measures and interviews were completed by trained staff. *Results:* Moderate-to-vigorous physical activity decreased and sedentary behavior increased over time. Age, body mass index, and height were significant predictors of systolic blood pressure. Height was the only significant predictor of diastolic blood pressure. Age (negative relationship), cognitive and social factors were significant predictors of moderate-to-vigorous physical activity. Age and maturity (more advanced breast stages) were significant predictors of body mass index. *Conclusions:* Promoting healthy lifestyles in adolescent, African American girls should include preventing the decline in physical activity by developing positive social networks.

Key Words: Longitudinal Study, Physical Activity, Body Mass Index, Blood Pressure, Obesity, African American Girls

Introduction

Obesity and related health compromising conditions (e.g., diabetes and hypertension) are the primary public health challenges in the United States (U. S. Department of Health and Human Services, 2000) and possibly the world (Kettaneh et al., 2005). In the United States, the prevalence of overweight and obesity among children and adolescents has more than doubled during the past three decades and the trend is escalating (Miech et al., 2006, Ogden et al., 2006, Ogden et al., 2002, Troiano et al., 1998). The associated consequences of overweight status are type 2 diabetes, hypertension, poor quality of life in childhood and increased morbidity and mortality in adulthood (Daniels et al., 2005, Ebbeling et al., 2002, Miech et al., 2006, Schwimmer et al., 2003, U. S. Department of Health and Human Services, 2000, Williams et al., 2005).

African American females are at greater risk for overweight, physical inactivity, and the related consequences of excess weight and physical inactivity compared to other racial/ethnic groups (females and males) and males of all racial/ethnic groups (Mensah et al., 2005, U. S. Department of Health and Human Services, 2000). Identifying, describing, and understanding the predictors of overweight status, physical activity, and sedentary behaviors are critical in developing effective interventions and prevention programs; however, few longitudinal studies have been conducted, particularly in adolescents and children. In one longitudinal study, Finnish girls who remained active over six years had significantly lower subscapular skinfold thickness, but not body mass index (BMI), compared to sedentary girls (Raitakari et al., 1994). Only one longitudinal study with African American girls was found (Kimm et al., 2005, 2002, 2002, & 2000); the results were that each decline in physical activity of 10 metabolic equivalent-times per week was associated with an increase in BMI of .14 kg/m^2 and in sum of skinfold thickness of .62 mm for African American girls (Kimm et al., 2005). In the Kimm et al., (2005) study, the physical activity measure was self-report in which the girls recalled physical activities outside school hours during the previous year. In the current longitudinal study, the physical activity measure was a bi-annual, self-report of the previous seven days' physical activities. This study's activity assessment was more frequent and comprehensive (all physical activities) compared to previous research. Additionally, the current longitudinal study is unique because the patterns and predictors of physical activity, blood pressure, and body mass index were included in the four year study of African American girls, starting at age twelve or thirteen. The specific research questions were:

1) Do body fat, maturity, and physical activity predict blood pressure values?
2) Do body fat, maturity, and psychosocial and environmental variables predict physical activity?
3) Do maturity and physical activity predict body fat?

Findings from this longitudinal study combined with data from other studies can guide the development of effective interventions to prevent overweight status and physical inactivity in vulnerable populations, particularly African American girls.

Methods

Subjects and Recruitment

Sixth grade is an important developmental period for health behaviors and physical maturation. We recruited all 120 sixth grade girls from one middle school in a large, urban, southwestern city in the United States, which was predominantly African American (93% African American, 6% Hispanic, 1% non-Hispanic white). Approximately 54% of the students were on the federal program for free or reduced lunch. The school had relatively low mobility rates (i.e., movement into, out of, or within the school district during a school year), simple feeder patterns (i.e., most students attended the same high school), and a supportive school administration (i.e., enthusiastic principal, assistant principals, and teachers). The school district and the university's internal review board approved the study, which included parental consent and child assent forms. The methods for each measurement are described below.

Anthropometry

The anthropometry measures included height, weight, circumferences, and skinfolds. Reliable and valid assessments were used in this study. Height was taken without shoes on a portable Harpenden stadiometer. Weight was taken on a balance beam scale. Four circumferences were taken with a retractable inelastic tape on the arm, abdomen, hip and lower thigh. Five skinfolds were measured with a Holtain skinfold caliper on the medial calf, lower thigh, triceps, subscapular, and abdominal. Measurement procedures followed Lohman et al., (1988), except for the lower thigh skinfold. The technique for the lower thigh skinfold is described in Sangi et al., 1992. Based on previous research (Mueller et al., 1987), the lower thigh skinfold is a valid indicator of lower body subcutaneous fat in adults. Also, we computed a waist/thigh ratio because this ratio was the first abdominal adiposity index devised using circumferences (Ashwell et al., 1982). Moreover, in a cross-sectional study of 10 to 14 year old children, the waist/thigh ratio was consistent with skinfold measures in statistically reflecting the contours of the human body as far as distinguishing abdominal versus lower body patterns of fat distribution, whereas the waist/hip ratio was not (Mueller et al., 1990).

The reliability of Healthy Growth's anthropometric measures was at an acceptable and very high level with intra-class correlations of 0.95 or greater for most measures except skinfolds (typically > 0.90) and circumference ratios (waist/hip and waist/thigh that ranged from 0.83 to 0.90). For example, the intra-class correlation coefficients for both same observer and different observer repeated measures were above 0.95 for height, weight, BMI (weight/height^2), abdominal circumference, arm circumference, hip circumference, and thigh circumference and above 0.93 for calf skinfold, subscapular skinfold, and abdominal skinfold. All correlations have been reported in detail earlier (Mueller et al., 1996).

The set of skinfolds and circumferences provide a complete list of variables useful in studies of fatness or obesity and anatomic fat distribution. Circumferences and skinfolds were taken on the right side of the body. Skinfold measurements are potentially less reliable than other anthropometric measures (Hass and Flegal, 1981). Thus, skinfolds over 20 mm were remeasured and the resultant values averaged to improve reliability, which tends to diminish with increasing skinfold thickness (Marks et al., 1989). The measurements were taken with one technician performing the procedures and another acting as a recorder. Standard anthropometric techniques in terms of site and instruments were followed (Cameron, 1984).

Blood Pressure

The blood pressure measures were systolic and diastolic blood pressures, mean arterial pressure, and pulse. The Dinamap 8100 automatic monitor was used to assess these values. The equipment was calibrated before data collection began. All staff was trained for about two hours on the use of the instrument. Before the measurement, each subject sat quietly for several minutes (a five minute rest period) while the staff member explained the procedure. The staff member then selected the appropriate size cuff based on the measured circumference of the right arm. Five cuff sizes were available. The cuff was placed on the right arm (Update on the Task Force Report, 1996) and the subject sat on a chair with her feet flat on the floor with her arm elevated to the heart level. Two measurements were taken exactly one minute apart and were then averaged for analyses. Between the two measurements, the subjects were instructed to raise their arms, and open and close their fists three times. This procedure allows for filling of the blood vessels thus preventing artificially lowering the blood pressure due to the recent constriction (Labarthe, 1991).

Physical Activity

The frequency, duration, and intensity of physical activity were assessed. The project investigators developed a physical activity frequency interview. It included a list of 41 activities from sedentary behaviors to high intensity physical activities. Observations of girl's physical activity behaviors and published literature were used to develop the list of activities appropriate for our population (e.g., Ross et al., 1985). An intensity index was used to classify the activities as light, moderate, or vigorous. The items per category were: sleeping (n = 1), sedentary (n = 6), light activity (n = 2), moderate activity (n = 11) and vigorous (n = 21). Each activity was assigned a MET value based on previous research (American College of Sports Medicine, 1991; Blair, 1991). One MET is equivalent to an oxygen uptake of 3.5 $\text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$[17]. Sleeping had a MET value of 1, sedentary behaviors had a MET value of 1.5, light activities had a MET value of 2, moderate activities had MET values of 3, 4.5, or 5; and vigorous activities had MET values of 6.5, 7, or 8.5. With the MET value, minutes in the activity, and body weight, we calculated kilocalories burned. The following standard formula (American College of Sports Medicine, 1991) was used to calculate average daily kilocalories burned in activities:

(weekly hours in activity X MET value of activity X weight in kilograms) / 7

During the interview, the subjects were asked if they participated in each activity in the last seven days, how many times they participated, and how long they participated. For the physical activities, subjects were also asked if the activity made them breathe fast or their heart beat faster. If so, they were asked how long their breathing and heartbeat were faster than usual. A higher MET value (1.5 was added to the MET value) was assigned for the minutes that the subject's breathing or heartbeat was increased during an activity. This procedure was used to accurately account for the intensity of an activity because the same activity can be performed at a low, moderate, or high intensity. The reliability and validity of this interview procedure and instrument have been documented (Simons-Morton et al., 1994). Intra-observer and inter-observer test-retest reliabilities were conducted on a sample of 21 girls who completed a second interview after the first interview. The correlation coefficients for the test-retest reliabilities ranged from .70 to .92.

At the end of the interview, the interviewer rated the overall quality of the girl's responsiveness on a scale of 1 to 5 with one being poor and five being excellent. The criteria for the ratings were attentiveness, ability to recall activities, ability to estimate time, and overall quality of interview. The purpose of the ratings was to identify girls, who during the interview were very inattentive or disinterested. If the interview's overall quality was rated as poor, the subject was eliminated from the analyses.

Predictors of Physical Activity

Factors and conditions potentially related to physical activity were assessed. A multidimensional model of determinants of physical activity based on operant and cognitive learning theories developed by Sallis and Hovell (1990) was used to assess predictors of physical activity. The model's premise is that learning theories and learning processes provide a comprehensive basis for explaining and influencing behavior. Therefore, the model is a useful conceptual framework to understand the complex behavior of physical activity (Table 1) (Sallis and Hovell, 1990).

Table 1. A Model of Determinants of Physical Activity Based on Learning Theory Adapted From Sallis and Hovell (1990)

Antecedents		Consequences	
Distal	**Proximal**	**Proximal**	**Distal**
Environmental Factors	*Environmental Factors*	*Environmental Factors*	*Environmental Factors*
Climate		Equipment failure	Hot/cold temperatures
Air quality	Convenience of facilities	Pleasantness of exercise setting	
	Safety of neighborhood		
Social Factors	*Social Factors*	*Social Factors*	*Social Factors*
Past modeling and support	Friend modeling	Praise	Physical attractiveness
	Media influences	Criticism	Being in shape
		Competing opportunities	
Cognitive Factors	*Cognitive Factors*	*Cognitive Factors*	*Cognitive Factors*
Normative beliefs	Exercise knowledge	Exhaustion	Anticipated health benefits
	Self-efficacy	Positive/negative moods	Fear of injury
Physiological Factors	*Physiological Factors*	*Physiological Factors*	*Physiological Factors*
Health Status		Heart rate	Weight change
Coordination	Injury	Perspiration	Fitness
		Breathing rate	Chronic injury
Other Personal Factors	*Other Personal Factors*	*Other Personal Factors*	*Other Personal Factors*
Education		Smoking	General risk taking
Income	Diet	Alcohol use	
Weight control history	Other health-related behaviors		

The multidimensional model (Sallis and Hovell, 1990) has five classifications: 1) environment (e.g., characteristics of the physical environment, climate, convenient access to facilities, safety in neighborhood); 2) social (e.g., modeling, social support, encouragement, praise, teasing, criticism); 3) cognitive (e.g., knowledge, perceptions, intentions, health benefits, fear of injury); 4) physiological (e.g., coordination, fatigue, exertion, perspiration, breathing hard, relaxation, soreness) and 5) other personal factors (e.g.,. education, income, smoking, alcohol use, injury history, other health behaviors). An important structure to the multidimensional model is consequences and antecedents. Within each of the five classifications, variables representing both consequences (effects that can occur after physical activity such as fatigue, praise, health benefits) and antecedents (influences that precede participating in physical activity such as expectations, attitudes, knowledge, encouragement, access to facilities) are included in the model.

We adapted this theoretically based multidimensional model (Sallis and Hovell, 1990) and developed The Predictors of Physical Activity Questionnaire with 54 items. The questionnaire includes 4 environment, 16 social, 18 cognitive, 9 physiological, 1 other personal factor, and 6 self-efficacy items. We added the self-efficacy classification because self- efficacy perceptions can be a strong predictor of behavior (Bandura, 1986). All analyses of this questionnaire were by the six broad classifications and not by the consequences and antecedents dimensions.

The questionnaire was interview administered. The response categories were: yes (4), sort of yes (3), sort of no (2), and no (1). For the self-efficacy subscale only, the response categories were: very sure (4), sort of sure (3), sort of not sure (2), and not sure (1). As a measure of a scale's internal consistency, the Cronbach's alpha coefficient for the questionnaire was .97. The individual subscales Cronbach's alpha coefficients were: cognitive-.91; social-.89; physiological-.84; self efficacy-.79; and environmental-.63. The personal factor classification had only one item and therefore no Cronbach's alpha coefficient was calculated. Cronbach alpha coefficients ≥ 0.70 is the standard criterion for new scales (Nunnally and Bernstein, 1994).

The test-retest (the time frame for the first and second administration was 7 to 36 days) correlation coefficients (Pearson for normally distributed scores or Spearman for distributions not normally distributed) were: overall questionnaire (Pearson r=.82); cognitive (Pearson r=.76); self efficacy (Spearman r=.73); environment (Spearman r=.63); social (Pearson r=.56); and physiological (Pearson r=.22). All correlation coefficients were significant (p≤0.001) except the physiological classification.

Stage of Maturation

Each subject self-assessed her secondary sex characteristics by comparing her body to drawings of the Tanner stages (Tanner, 1990). Each drawing was accompanied with a detailed description in writing. The drawings depict five successive stages of breast development and pubic hair growth. The first stage is preadolescence and the fifth stage is the mature adult. The five stages of pubic hair development were: 1) no pubic hair, 2) a little long, lightly colored hair, 3) the hair is darker, coarser, and more curled and thinly covers a larger area, 4) the hair is dark, curly, and coarse and has not spread out to the thighs, and 5) the hair has a triangular pattern as it spreads out to the thighs. The five stages of breast development were: 1) the nipple is raised and the rest of the breast is flat, 2) the nipple is raised and the breast is a small mound, 3) the areola and the breast are larger than stage two and the areola does not stick out away from the breast, 4) the areola and the nipple make up a mound that sticks up above the shape of the breast, and 5) the breasts are fully developed, only the nipple sticks out, and the areola has moved back to the general shape of the breast. The self-assessment activity was performed in a private area with instruction from a woman staff member. This procedure is a valid noninvasive method to measure female maturation (Kozinetz, 1986). Additionally, the subjects were asked about onset of menses.

Health Behavior Questionnaire

Health behaviors that affect growth, maturity, fitness, blood pressure, and physical activity were assessed. The Youth Risk Behavior Survey Questionnaire developed in 1990 by the Centers for Disease Control and Prevention was modified to assess alcohol, tobacco, oral contraceptive use, recent medical conditions, and dieting behaviors. The girls were asked to read each question carefully, be completely honest, and know that their responses were confidential.

We selected 26 items from the Youth Risk Behavior Survey

Questionnaire. Seven items asked about cigarette use and chewing tobacco. For example, "How old were you when you smoked a whole cigarette for the first time?" "During your lifetime, how many days have you smoked at least 1 cigarette?" These two questions had seven response categories. Four questions asked about alcohol use. For example, "How old were you when you had your first drink of alcohol other than a few sips?" This question had seven response categories. Six questions asked about body weight. For example, "Do you think of yourself as being: very underweight, slightly underweight, about the right weight, slightly overweight, or very overweight." "Which of the following are you trying to do- lose weight, gain weight, stay the same weight, or I am not trying to do anything about my weight." One question was about the use of oral contraceptives. Eight questions were about illegal drug use. For example, "During your life, how many times have you used marijuana?" For this question there were seven response categories.

A test-retest reliability study of the Youth Risk Behavior Survey Questionnaire was conducted with 1,679 students and the results indicate that students report health behaviors reliably over time (Brener et al., 1995). The validity of self-report measures of illicit drug use, alcohol use, and tobacco use has been documented (Brener et al., 1995).

Analysis Plan

For descriptive purposes, the means and standard deviations for blood pressure, physical activity, and anthropometric measures were calculated for each of the 8 time points. For the 6 important variables in the study, body mass index, weight in kilograms, hours per week of moderate-to-vigorous physical activity, hours per week of sedentary behavior, systolic blood pressure, and diastolic blood pressure, their time-specific means and 95% confidence intervals were further plotted to facilitate detecting trends over time.

The statistical analyses addressed the three research questions: 1) Do body fat, maturity, and physical activity predict blood pressure values? 2) Do body fat, maturity, and predictors of physical activity predict physical activity? 3) Do maturity and physical activity predict body fat? The three dependent variables were modeled in three separate groups of longitudinal regressions.

The following measures were independent variables for the appropriate regressions: (i) a body fatness measure (BMI), a body fat distribution measure (waist-thigh ratio), (ii) maturity measures (breast and menarche stages), (iii) physical activity (moderate to vigorous minutes), (iv) a combination of BMI and moderate to vigorous minutes, (v) psychosocial measures (social and cognitive factors), (vi) physical fitness (VO_{2max}), and (vii) height.

The independent variables were selected from a larger series of measurements in preliminary analyses. The correlations between physical activity (moderate-to-vigorous minutes in physical activity), blood pressure and seven different body fat indices were performed. The body fat measures were: BMI (weight/height^2), Rohrer Index (weight/height^3), abdomen circumference, and sum of five skinfolds—medial calf, lower thigh, triceps, subscapular, and abdomen. The indices of abdominal fat distribution were waist-hip ratio, waist-thigh ratio, and conicity index. Both BMI and waist-thigh ratio were chosen to enter the regression analysis because these variables had the strongest correlations with systolic blood pressure and had the least correlation with each other in the preliminary analysis.

The maturity measure (breast stages) was selected because it had a strong and significant correlation with body mass index (BMI). Furthermore, the variable moderate-to-vigorous minutes of physical activity was selected as the measure of physical activity, because it represents the intensity most associated with health benefits and national standards (U.S. Department of Health and Human Services, 1996, 2000; Sallis, 1994).

A plot of moderate to vigorous physical activity minutes against BMI showed considerable variance in the middle of the graph, indicating perhaps the need for a combination term (RiskBMI) to explore the possible synergism between the two variables. Thus, a combination term was created representing cardiovascular risk: the product of BMI and physical activity reversed (scale values were reversed, i.e., low BMI and high activity are scored as 'lowest risk' and so on).

Cognitive and social factors (psychosocial predictors) were chosen to be included in the regression analysis because they had the highest alpha coefficient values (i.e., the most internally consistent scales).

Mixed model with fixed effect for each independent variable and random intercept among individuals was used in model fitting. Autoregressive 1 covariance structure was also specified in the model to accommodate within-subject correlations over time. These model specifications were the same for both univariate and multivariate analyses. After fitting univariate model for each potent predictor, those with p-value <= 0.25 were chosen to be the first group of candidates in the multivariate analysis, and a backward selection process was completed until the final predictors all having significant p-values of less than 0.05, based either on the Wald's test or the Akaike Information Criteria (AIC). PROC MIXED procedure of SAS® 8.0 was used in modeling.

Height was included in the regression model when BMI and waist thigh ratio were the dependent variables, because height is a measure of overall physical size and maturation, a possible confounder for blood pressure.

Results

Subject retention and attrition

The patterns of subject retention and attrition are presented in Table 2. For each measurement period, any girl enrolled in the school at the grade level for that year could participate in the study. We started with 120 sixth grade girls as the total subject population from which to recruit the participants. At the end of four years, 189 girls participated in the Healthy Growth study; 50 girls participated in one measurement only; 9 girls participated in all 8 measurements (Table 2).

Table 2. Healthy Growth: Subject retention and attrition

	1 time	2 times	3 times	4 times	5 times	6 times	7 times	8 times
n	50	32	31	19	17	11	20	9
% of 189	26.5%	16.9%	16.4%	10.1%	9.0%	5.8%	10.6%	4.8%

Nine participants had systolic blood pressure, diastolic blood pressure, body mass index, and hours per week of moderate-to-vigorous physical activity at all 8 time points.

Selected variables and changes over time (trends)

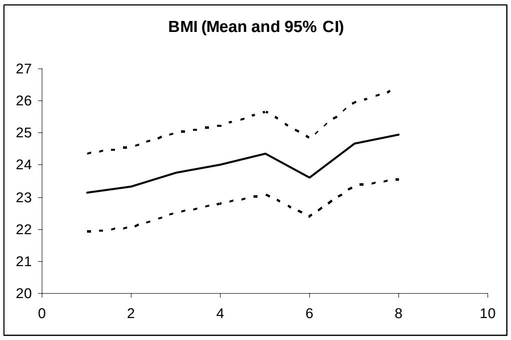

Figure 1. Healthy Growth – Body mass index trends

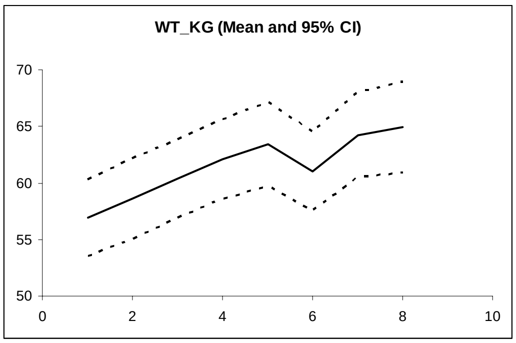

Figure 2. Healthy growth-Weight in kg trends

As expected for adolescents, body mass index and weight increased during each year with a decrease at the sixth measurement period (Figures 1 & 2). Hours per week of moderate-to-vigorous physical activity decreased over time with an increase at the sixth measurement period (Figure 3). The final measurement period (i.e., eighth assessment) showed the lowest subject participation in moderate-to-vigorous physical activity during the entire study (Figure 3). Hours per week of sedentary behavior showed an up and down pattern over the eight measurement periods (Figure 4). For the first measurement, the participants engaged in the least amount of sedentary behavior (approximately 35 hours per week) (Figure 4). For the final measurement (i.e., eighth assessment), the participants reported the most time spent in sedentary behaviors (approximately 45 hours per week) (Figure 4). Systolic (except for a decrease at the third measurement period) and diastolic (except for an increase at the sixth measurement period) remained relatively stable during the four year time period (Figures 5 & 6).

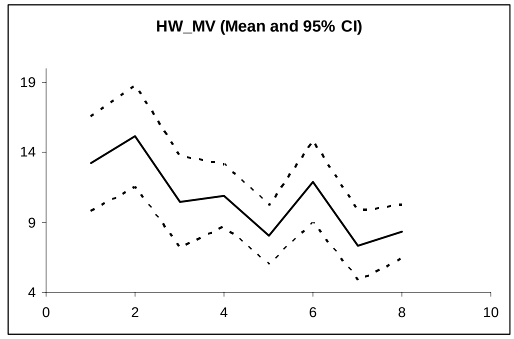

Figure 3. Healthy Growth: Hours per week in moderate-to-vigorous trends

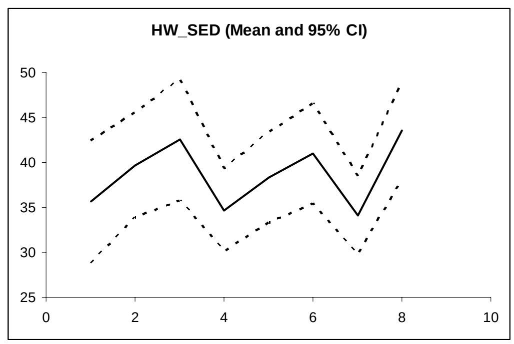

Figure 4. Healthy Growth – Hours per week engaged in sedentary behavior

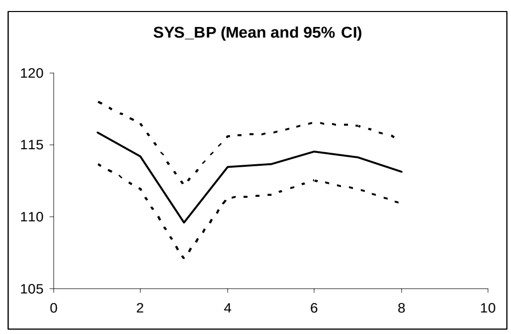

Figure 5. Healthy Growth: Systolic blood pressure trends

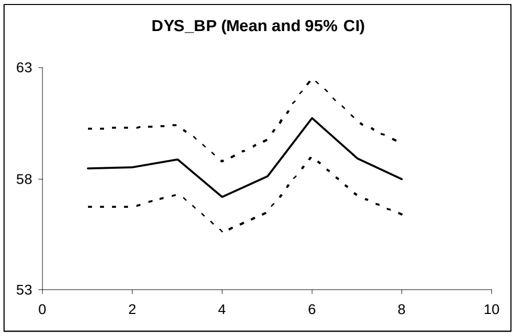

Figure 6. Healthy Growth – Diastolic blood pressure trends

Analyses of three research questions

A mixed model was used to analyze the unbalanced longitudinal design data. Because the dependent variables were not normally distributed, log transformed values were used for the analyses. During the four years of the study, age, body mass index, and height were significant predictors of systolic blood pressure (Table 3).

Table 3: Healthy Growth: Predictors of systolic and diastolic blood pressure, moderate-to-vigorous physical activity, and body mass index (fitting log outcomes)

Outcome	Variable	Estimate	Standard Error	P Value
SYS_BP				
	AGE	-0.13	0.04	0.003
	AGE*AGE	0.00	0.00	0.005
	BMI	0.01	0.00	<.0001
	MIN_MV	0.00	0.00	0.099
	HT	0.26	0.08	0.001
	RISKBMI	0.00	0.00	0.171
DYS_BP				
	MIN_MV	0.00	0.00	0.104
	HT	0.33	0.11	0.003
MIN_MV				
	AGE	-0.20	0.04	<.0001
	COGN	0.51	0.16	0.001
	SOC	0.61	0.14	<.0001
BMI				
	AGE	0.02	0.00	<.0001
	BREAST <= 3	-0.04	0.01	0.001
	BREAST 4	-0.03	0.01	<.0001
	BREAST 5	ref.		
	MENSE	0.01	0.01	0.301
	MIN_MV	0.00	0.00	0.396

Height was the only significant predictor of diastolic blood pressure (Table 3). Age (negative relationship), cognitive and social factors were significant predictors of moderate-to-vigorous physical activity (Table 3). Age and maturity (more advanced breast stages) were significant predictors of body mass index (Table 3).

Discussion

The Healthy Growth Study was unique because there are few longitudinal studies in the United States. Furthermore, there is an absence of longitudinal data (perhaps one or two other studies) about the predictors of blood pressure, physical activity, and body fat in African American girls. We found that height (systolic and diastolic blood pressure), age (systolic blood pressure), and body mass index (systolic blood pressure) were significant predictors of blood pressure. Physical activity was not a significant predictor of blood pressure in this racial/ethnic group for this age range. Moderate-to-vigorous physical activity was negatively related to age and positively related to psychosocial predictors (e.g., social and cognitive factors). Body mass index was significantly related to age and maturity. Blood pressure remained relatively stable during the four years. Hours per week of moderate-to-vigorous physical activity decreased and sedentary behavior increased. In this study, we found that the number of hours per week engaged in sedentary behavior increased over time. Also, another study reported that in youth from 10 to 16 years of age, time watching TV/computer increased with age from 1.4 to 2.2 hours per day (Deheeger, 2002). Sedentary behavior has been associated with obesity in youth (e.g., Robinson, 1999).

During the four years, we found a decrease in physical activity among African American girls. In a review, it was noted that the decline in physical activity with age may be the most consistent finding in physical activity epidemiology (Sallis, 2000). The decline is steepest between the ages of 13 and 18. The decline varies by type and intensity of the physical activity. This decline in physical activity with age is antithetical to public health goals (Sallis, 2000). In the United States, a major initiative has been funded to reverse the decline in physical activity among adolescent girls including African Americans (Rohm-Young et al., 2006). To reverse the decline in physical activity, the predictors and determinants of physical activity should be identified. These factors are essential in developing prevention programs.

In our longitudinal study, social and cognitive factors were significant predictors of physical activity. Consistent with the longitudinal findings from *The Healthy Growth Study,* the Trial of Activity for Adolescent Girls (TAAG), (a randomized, multi-center field trial of 36 middle schools to test an intervention to reduce the decline in physical activity in adolescent girls, starting in sixth grade), is promoting the social aspects of doing activities with a friend (Rohm Young et al., 2006). Similarly, in a cross-sectional analysis with sixth and eighth grade girls, peer social networks (i.e., physical activity with friends) were significantly related to physical activity levels (Voorhees et al., 2005). For adolescent African American girls, we recommend further study of social support and peer networks to increase physical activity and prevent the decline in physical activity during adolescence.

We found a decline in physical activity over the four years but physical activity was not a significant predictor of body mass index. Another study with non-Hispanic white and Black girls (Kimm et al., 2005) reported that the decline in physical activity played a key role in weight gain. Inactive girls had three times greater gains in body mass index and were approximately 10 to 15 pounds heavier in the tenth year of the study. Two major differences may account for the seemingly, discrepant findings. Our study was a 4-year observational study and the Kimm et al., 2005 study was a 10-year observational study. Furthermore, in this paper, we did not analyze our results by active and inactive groups. However, as a public health goal, we believe as do Kimm et al. (2005) and Katteneb et al. (2005) that preventing the decline in physical activity among adolescent girls can have many positive health benefits including maintaining a healthy weight and preventing obesity.

Several limitations of the study should be noted. This project was a one school study with a small sample size in a large urban, southwestern, United States city. We tracked girls for four years with a total of 189 participants and 9 girls completed all 8 assessments. Because of the small sample size, the attrition level, and limited geographical area caution is required in generalizing our results to all African American girls. Nevertheless, our results are unique because there are very few studies with African American girls.

In analyzing longitudinal studies, there are statistical concerns. Our longitudinal data had unbalanced observations in that not all subjects had measurements for all 8 time points. This trend could be either due to loss to follow-up, where all observations after a certain time point are missing, or due to intermittent participation in the study, where there were irregular gaps among the measurements over time. We believe that missing data under both circumstances are unlikely to be due to mechanisms related to the measurement process, and are therefore completely random. This assumption justifies our using the mixed model, which is likelihood-based and not seriously affected by missing data in terms of drawing valid inferences. (Diggle et al., 1994; Littell et al., 1996). After fitting the multivariate models and identifying the predictors for each dependent variable, we did not perform any residual analyses and detect any outliers. This analysis was not performed because of the current lack of proper statistical methods for longitudinal models. We hope to do the diagnostics later, when such methods are developed. However, we did conduct post-hoc analyses. At time 6 when 15 new girls joined the existing cohort, we found no significant differences related to the primary study variables between the new and old participants.

Our longitudinal study had several strengths including the measures and procedures. The physical activity checklist used in this study to assess physical activity is still the standard and has been used in many recent studies with adolescent girls (Grieser et al., 2006). The anthropometric assessments and self-report scales were reliable and valid (Taylor et al., 2002). *The Healthy Growth Study* had the same female project coordinator during the entire study and thus continuity and reliability were maintained with the participants. All assessments were conducted in the schools during the school day; therefore, logistical convenience was provided for the participants.

Conclusion

In the four year observational project, *The Healthy Growth Study,* African American girls decreased their physical activity, increased participation in sedentary behavior, and increased body mass index primarily related to maturity. In our sample, psychosocial predictors of physical activity were social and cognitive factors.

In another study, for a 10-year period from ages 9 to 10 to 19 years old, prevalence of overweight and obesity during adolescence doubled. Half of the Black girls were overweight and one third of the Black girls were obese (Kimm et al., 2002). Furthermore, the prevalence of overweight among children in the United States continues to increase especially among Mexican-American and non-Hispanic Black adolescents *(Ogden et al., 2002).* These statistics should sound an alarm for public health professionals *(Kimm et al., 2002).*

To reduce the effects of obesity on morbidity in childhood and adulthood, identifying critical time periods for the prevention of overweight in vulnerable populations is essential (Dietz 2004). Adolescence is critical period when overweight may occur and increasing rates of weight gain vary by racial/ethnic background (Dietz 2004). Therefore, longitudinal studies such as *The Healthy Growth Study* are needed to develop effective obesity prevention programs in which specific strategies for various cultural and racial/ethnic groups should be considered.

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