R40 MC 00241, Growth and Development Longitudinal Follow-up: Phase 2, University of Maryland.

I. Introduction

A. Nature of the research problem

Pediatric obesity[1] is a serious public health problem that has increased threefold over the past three decades, particularly among minority children from low socioeconomic status (SES) families.(2-4) Based on the 2005-2006 National Health and Nutrition Examination Survey (NHANES), 17.6% of adolescents (age 12-19 years) are obese; when the sample is restricted to African American adolescents, the rate increases to 22.9%. (3) Adolescents from low SES families (indexed by low maternal education) are disproportionately affected by obesity. (5)

B. Purpose, scope, and methods of the investigation

Our primary hypothesis is that intervention group adolescents would be less likely to experience the increases in BMI and body composition that are characteristic of early adolescence than control group adolescents. Our secondary hypotheses are that intervention group adolescents would be more physically active and less likely to consume high fat snacks and desserts than control group adolescents.

C. Nature of the findings

II. Review of the Literature

Pediatric obesity is associated with both immediate and long-term health problems, including hypertension, asthma, musculoskeletal problems, obstructive sleep disorders, Type II diabetes, depression and social stigmatization.(6, 7) Data from our laboratory have shown that among a community sample of adolescents, body composition and physical activity were independently associated with insulin sensitivity, indicating that precursors of chronic disease are present in adolescence (8). Not only do obese children suffer physical and psychological consequences, (9) but obesity during childhood and adolescence is a strong risk factor for adult obesity. (10-13).

Although obesity is a chronic disease that is influenced by genetic, metabolic, and physiologic factors, environmental and psychological factors also contribute to obesity and can be the focus of prevention efforts. (14) Effective goals of prevention are to increase physical activity, reduce sedentary activities, and decrease consumption of high fat foods – factors that have been associated with obesity. (14-16) Although there have been multiple attempts to reduce the prevalence of obesity, reviews of school-based interventions from the Cochrane Collaboration (17) and a meta-analysis of 64 prevention trials for children and adolescents (18) found very limited impact on BMI or obesity.

One common criticism of school-based and after-school programs is their lack of integration into home and community activities. Children's weight status and dietary patterns are strongly influenced by family environmental factors. (19, 20) We developed and evaluated a home- and community-based health promotion/obesity prevention program for urban adolescents. We focused on early adolescents in low-income, minority communities for several reasons. First, not

[1] Based on body mass index (BMI) calculated by weight in kg/height in m^2. Overweight is defined as gender-specific BMI-for-age $\geq 85^{th}$ percentile and $< 95^{th}$ percentile and obesity is defined as gender-specific BMI-for-age $\geq 95^{th}$ percentile (http://www.cdc.gov/growthcharts). 1. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. Pediatrics 2007;120 Suppl 4:S164-92.

only are early adolescents at high risk for weight gain (21), but overweight during early adolescence increases the risk for adulthood obesity (13). Second, early adolescents are often very focused on their bodies as they undergo the biological and psychological changes associated with the transition to adulthood. (22) Third, as young adolescents gain independence, they often have access to money for after-school snacks and visit local convenience stores, making decisions for themselves related to diet and physical activity. (23) Finally, adolescents from low-income, minority families are disproportionately at risk for overweight. (3)

III. Study Design and Methods

A. Study design

Randomized controlled trial.
The research protocol was approved by the University's Institutional Review Board. Adolescents and caregivers provided written informed assent and consent, respectively, prior to data collection and were compensated for all evaluation visits.

Adolescents and their caregivers participated in a baseline evaluation conducted in a university-based laboratory between July 2002 and May 2004, which included anthropometrics and questionnaires on demographics, diet, and physical activity. Questionnaires were self-administered on a laptop computer. Questions were presented aurally through headphones and visually on the screen, and responses were selected with a mouse.

After a cohort of approximately 30 adolescents completed the baseline evaluation, they were randomized into intervention or control groups. The randomization was stratified by growth history, baseline weight status (normal vs. overweight/obese), gender, and age.

Adolescents randomized to the intervention group participated in an introductory group session with their caregivers. They each received a college-age mentor, who delivered a 12-session home- and community-based intervention over approximately four months. The majority (>90%) of mentors were race and gender-matched to the adolescents. The manualized intervention was called "*Challenge!*" to symbolize the personal challenges that were part of each lesson. The intervention was based on social cognitive theory, (25) developed in collaboration with an advisory board of adolescents who participated in the formative phase of the project, and included a rap video. The rap video, which included lyrics and images promoting healthy eating and physical activity, was shown to intervention participants at their first *Challenge!* lesson. The 12 intervention lessons included information and opportunities for the adolescents to experience a range of foods and physical activities within their home and community. Each session included making a healthy snack and engaging in a physical activity. Goal setting and feedback were central components of the intervention, as adolescents learned to set dietary and physical activity goals for themselves, to track and evaluate their progress, and to revise their goals as necessary. Mentors delivered the intervention in the adolescents' home and accompanied them on field trips to community sites (convenience stores, grocery stores, and physical activity sites) to deliver specific lessons. An adult family member had to be home during each lesson, family members were invited to participate, and materials were left following each lesson. Each cohort included a group trip, usually to a park or skating rink, and a graduation celebration that marked the conclusion of the intervention. The college mentors were taught to use principles of motivational interviewing (26) to encourage the adolescents to make changes in their diet and physical activities. The mentors met weekly for group supervision with an advanced graduate student in psychology. Process evaluations, including contact logs, parent questionnaires, and observations were conducted to assess the integrity, dose, fidelity, and reach of the intervention.

Adolescents randomized to the control group received standard care. They did not receive a mentor or any contact between baseline and the follow-up evaluations.

Two subsequent evaluations were scheduled: post-intervention (average of 10.9 (SD = 4.83) months following the baseline evaluation) and delayed follow-up (average of 24.26 (SD=5.38) months following the baseline evaluation). The adolescents and their caregivers returned to the university-based laboratory, where they repeated the baseline evaluations. The research assistants on the data collection team were not aware of the adolescents' intervention status or baseline measurements.

B. Population studied

Urban adolescents.

C. Sample selection

Participants

The trial was based at a university medical center in a large mid-Atlantic city. Two samples of adolescents were recruited to participate in a randomized controlled trial of health promotion/obesity prevention. The first sample had been participating in a longitudinal investigation of child growth and development since infancy. All children were born at term (> 37 weeks) with birth weight appropriate for gestational age, and had no documented congenital or disabling conditions. Approximately 17.9% of the children had experienced growth faltering in the first two years of life (weight-for-age or weight-for-height < 5th percentile based on age and gender-adjusted growth charts), but by six years of age, they had experienced growth recovery and their growth parameters were > 5th percentile. (24) The second sample of adolescents was recruited from urban middle schools.

Eligibility criteria for both samples included age (11 to 16 years), residence in one of the low-income, predominantly African American communities surrounding the medical center, and willingness to participate in a randomized controlled trial of a health promotion program. Weight was not a criterion and was not mentioned in recruitment. Two hundred and thirty-five adolescents were enrolled and completed the baseline evaluation prior to randomization in the intervention.

D. Instruments used

Measures

Adolescents and caregivers reported basic demographic information including their age, gender, race/ethnicity, and highest grade completed. Caregivers reported on family size and family income. Using this information and the poverty ratio equation provided by US Census Bureau, each family's poverty ratio was calculated and compared with the 2004 poverty index, based on household size, number of dependents, and income (http://www.census.gov/hhes/www/poverty.html; (27).

The primary outcomes for the study were changes in BMI category and body composition at the post-intervention and delayed post-intervention evaluations. Secondary outcomes were changes in physical activity and diet.

Anthropometry

A trained staff member collected all anthropometrics for adolescents and their caregivers. Height was measured to the nearest 0.5 cm with a wall-mounted standiometer and weight was measured to the nearest 100 grams with a digital scale (Tanita, Tanita Co. Tokyo, Japan). BMI was

calculated as weight (kilograms) divided by height (meters^2). For adolescents, BMI values were converted to z-scores and percentiles based on the 2000 CDC age- and gender-specific tables using algorithms provided at http://www.cdc.gov/growthcharts (28). Adolescents were divided into the following categories based on their age-adjusted, gender-specific BMI percentiles: normal weight (< 85th percentile), overweight (≥ 85th percentile and < 95thpercentile), and obese (≥ 95th percentile). (1) Caregivers were grouped into the following categories based on their BMI values: underweight and normal weight (BMI < 25 kg/m^2), overweight (BMI ≥ 25 kg/m^2 and < 30 kg/m^2), and obese (BMI ≥ 30 kg/m^2).

Body Composition

Body composition was measured by Dual Energy X-ray Absorptiometry (DEXA) scan and bioelectrical Impedance Analysis (BIA). The DEXA scan was conducted at the General Clinical Research Center (which opened after *Challenge!* began), following a standardized protocol using a Hologic QDR 4500 W scanner. Due to limited availability of the DEXA, baseline measurements were available among 75% of participants. Percentage of body fat, fat mass (kg), and fat free mass (kg) were calculated using software provided by the scanner manufacturer.

BIA was measured on all participants. The BIA instrument (TANITA 300GS, Tanita Corp., Tokyo, Japan) uses the leg-to-leg contact electrode BIA system. Body composition values, including percentage of body fat, were obtained using the instrument's software without modification.

Physical activity

At the conclusion of each the laboratory evaluation, a uniaxial accelerometer (Actiwatch; Respironics, Inc.; Bend, OR) was placed on the right ankle with a non-removable, reinforced hospital band. The accelerometer was worn for ≥9 days next to the skin, under socks. Actiwatch software was used to reduce the accelerometer data. To be included in the analysis, days had to have complete data (i.e. full 24 hour period) with a daily average of at least 100 counts. Data were truncated after the 7th complete day. After data cleaning, there were an average of 6.16 days (SD = 0.80) of complete data for each adolescent at baseline.

Two summary scores were created: average daily activity counts per minute and minutes per day spent in play-equivalent physical activity (PEPA). To calculate average daily activity counts/min, time spent in sleep was excluded by eliminating 1-hour blocks of time with an average activity < 55 counts/min. This process resulted in an average sleep time of 8.05 hours/night (SD=0.98).

PEPA was calculated based on a sub-study conducted with 25 participants (10 boys and 15 girls, mean age (SD) = 14.6 (1.7) y). The participants wore Actiwatch accelerometers on the right knee and ankle during a 20 minute free play session in a gymnasium furnished with age-appropriate exercise equipment and toys. Knee placement of the Actiwatch has been correlated with energy expenditure, (29) but ankle placement was preferred by the participants. With the exception of three individuals who rode stationary bikes exclusively, the individual activity count means for ankle placement ranged from 1941 to 5924. Ankle and knee placement counts were highly correlated ($r = 0.94$, $p < .001$). We selected 1800 counts/min as a threshold for PEPA threshold using ankle placement for the Actiwatch. Both average daily activity counts/min and PEPA were skewed and normalized by taking the natural log.

Diet

Dietary patterns were measured with the Youth Adolescent Food Frequency Questionnaire (YAQ), an instrument that has been developed and validated for use with adolescents. (30, 31) The YAQ was self-administered and adolescents reported on the foods they consumed over the

past six months. Response categories differ by food. For example, most of the servings of snacks refer to a serving size of 1 small bag and respondents indicate the number of bags consumed in a month or week. The YAQ contains 131 total items and yields estimated scores on energy intake, macro and micronutrients, and daily servings of each food item consumed.

Total kilocalories and the number of servings consumed per day in six categories (fruits, vegetables, snacks and desserts, meats and main dishes, soda, and dairy) were examined. To reduce the possibility of reporting errors, we identified adolescents at baseline (n=24), post-intervention (n=20) and delayed follow-up (n=15) who had out-of-range values (< 500 kilocalories or > 5000) for caloric intake. There were no differences in results of analyses conducted with and without these adolescents; all data were retained.

E. Statistical techniques employed

Analysis Plan

An intention-to-treat analysis was conducted. The data were checked for skewness, kurtosis, and extreme outliers prior to analyses and were transformed as necessary. Preliminary analyses were conducted to examine baseline differences between the intervention and control groups. Chi square analyses were used with categorical variables and analysis of variance or Mann-Whitney-Wilcoxon test (for variables that violate the assumption of normality) with continuous variables (Table 1).

To assess the impact of the intervention on BMI category, body composition, physical activity, and diet, we examined the association between the intervention and control groups at the post-intervention and delayed follow-up visits employing longitudinal multilevel modeling techniques to examine change over time. (32, 33) The analyses were conducted controlling for baseline measurements, (34) age, gender, and growth history. Multilevel modeling accounts for the correlation of outcome measures within adolescents over time and differs from standard regression analyses in that the assumption of independence of responses inherent in a standard regression model is violated. (32, 33) Applying a similar methodology as described by Mujahid et al., (35) the impact of the intervention on change in continuous outcomes over time was estimated using a random mixed effects models approach (i.e., PROC MIXED SAS version 9.1; SAS Institute Inc., Cary, NC). The impact of intervention on change of binary outcomes was examined using marginal models of discrete variables and generalized estimating equations (GEE) (i.e., PROC GENMOD SAS version 9.1; SAS Institute Inc., Cary, NC).

In the longitudinal analyses, we examined the moderating effects of time, gender, and baseline BMI category, by including terms representing the intervention group interacted with time, gender, and BMI category. Because early growth history can alter the risk of obesity,(36) we conducted a subgroup analysis to assess direct or moderated effects of growth history on outcome measures. We also examined three-way interventions among intervention group, time, and gender. Significant interactions were explored using guidelines from Aiken and West. (37) Significant time by intervention interactions were interpreted as a significant difference in the intervention effect between the post-intervention and delayed follow-up. We conducted main effect analyses if there were no significant moderating effects. Significant intervention effects were interpreted as a significant change in the mean response, averaged over the follow-up visits. (Fitzmaurice)

IV. Detailed Findings

At baseline, 235 adolescents were recruited, 52% (121/235) intervention and 48% (114/235) control (Table 1). The mean age of the adolescents was 13.2 years (SD = 1.03). The adolescents

were evenly divided by gender (49% females), 97% were African American, 12% were overweight and 26% were obese. Forty-two adolescents experienced growth deficiency early in life, and were evenly divided by intervention status. In spite of stratification by BMI-for-age percentile, intervention group adolescents were more likely to be overweight/obese than control group adolescents, p = 0.04. There were no other group differences.

Within the intervention group, 52% (62/121) of the adolescents attended at least 10 of the 12 sessions, 15% (18/121) attended none of the sessions, and the remaining 33% (41/121) attended an average of 4.6 sessions (SD = 2.7).

At the post-intervention, data were available for 184/235 (78%) adolescents and at the delayed follow-up, data were available for 178/235 (76%) adolescents. There were no differences in retention by group assignment or by baseline anthropometry, physical activity, or dietary intake.

BMI Category

In longitudinal analyses, there was a significant time by intervention interaction (X^2 = 4.73, p = 0.030). At post-intervention there was an increase of 3.4% proportion of adolescents with a BMI $\geq$ 85th percentile among the control group, versus a decline of 4.6% among the intervention group (Table 2), however the difference was not significant (OR=1.66, X^2 = 0.94, p = 0.332). At delayed follow-up, adolescents in the control group were more likely to advance from normal to overweight or obese than adolescents in the intervention group, OR=7.94, X^2 = 7.68, p = 0.006. The proportion of adolescents with a BMI $\geq$ 85th percentile continued to increase in the control group, but remained steady in the intervention group (42.7% vs. 39.3%). There were no other significant interactions; age, gender, and growth history were not significant predictors of change in overweight status.

Body Composition

DEXA

There was no significant difference between intervention and control at baseline in total percent body fat. In longitudinal analyses, there was a marginally significant interaction between intervention and time (X^2=3.45, p=0.063) (Figure 2). Among intervention group members, there was a non-significant decline in percent fat over time (β=-0.30, X^2=0.26, p=0.611). Among control group members, there was a non-significant increase in percent fat over time (β=0.50, X^2=0.83, p=0.364).

Fat mass (kg) did not differ significantly between intervention and control groups at baseline. In longitudinal analyses, there were no significant interactions and no significant differences between the intervention and control groups at post-intervention (X^2= 0.80, p=0.371) or at delayed follow-up (X^2= 0.25, p=0.617) (Table 2).

Fat free mass (kg) did not differ significantly between intervention and control groups at baseline. In longitudinal data analysis, there was a statistically significant three-way interaction between intervention and time and gender (X^2=58.66, p<0.0001). Among males, fat free mass was significantly higher among intervention versus control members at post-intervention (X^2=7.42, p= 0.007), and delayed follow-up (X^2=11.96, p<0.001). Among females, there was no significant difference in fat free mass between intervention and control at post-intervention (X^2=0.04, p= 0. 842), or delayed follow-up (X^2=1.38, p=0.240).

The associations between changes in body composition (body fat percent, and fat mass) and the intervention were not moderated by gender, baseline BMI status, or growth history.

BIA

The total percent body fat did not significantly differ between intervention and control at baseline, or in longitudinal analyses either at post-intervention or delayed follow-up (Table 2). There were no significant interactions.

Physical activity
There were no significant differences between intervention and control groups at baseline, or in longitudinal analyses either at post-intervention or delayed follow-up for average daily activity counts. There were no significant interactions (Table 3)

There was no significant difference between intervention and control at baseline, or in the longitudinal analyses at post-intervention or delayed follow-up for mean daily minutes spent in PEPA ($\geq$1800counts/min). Over time the effects of intervention were moderated by baseline BMI (X^2 = 4.03, p =0.045). Among the adolescents with a BMI $\geq$ 85th percentile, the control group had an average 25.5 min less activity than the intervention group at post-intervention (X^2 = 5.57, p =0.018). At the delayed follow-up, the control group was less active than the intervention group, however the difference was not statistically significant (X^2 = 1.06, p =0.304). Among adolescents with a BMI $\geq$ 85th percentile, time spent in PEPA was more likely to decline over time among control group members (88.5 to 67.8 minutes) than among intervention group members (82.1 to 87.1 minutes) The control group had an average 18.6 min less activity than the intervention group (X^2 = 4.82, p =0.028). The interactions between intervention group and time were not significant.

Diet
In longitudinal analyses, there were main effects of time on caloric, total dietary fat, and fiber intake. Over time, both intervention and control group adolescents reported decreases in their intake of total calories, fat, and fiber. There was a significant intervention effect on snacks over time (X^2=4.46, p=0.032), with lower rates of consumption among intervention group members. The decline in the intervention group snack and dessert consumption (mean = 4.5 to 2.96/day) was significantly stronger than the control group decline (mean = 4.4 to 3.5/day). Effects were not moderated by time, BMI, gender, or growth history.

In longitudinal analysis of fried food consumption, the effects of the intervention were marginally significant at the post-intervention (X^2=3.15, p=0.076). Fried food consumption declined in the intervention group from baseline to post-intervention (mean=0.75 to 0.59/day), while consumption remained relatively constant in the control group (mean= 0.68 to 0.71/day). There were no significant differences in the other dietary categories.

V. Discussion and Interpretation of Findings

A. Conclusions to be drawn from findings (with reference to data supporting each).

Challenge! was designed to overcome many of the barriers that interfered with the success of previous adolescent obesity prevention trials.(14) The 12-session intervention was implemented in adolescents' homes by college mentors who accompanied the adolescents to neighborhood convenience stores and play grounds to promote healthy dietary choices and physical activity. Using the principles of social cognitive theory and motivational interviewing, the mentors helped the adolescents identify personal challenges and goals related to diet and physical activity. These implementation strategies were effective in promoting positive changes related to weight status, percent body fat, physical activity, and diet.

Weight Status
The adolescents in the intervention group did not advance in BMI category during the 2-year study period. In contrast, control group adolescents advanced in BMI category over time,

following a pattern of weight gain during adolescence that has been well-described.(2) The effects of the intervention were not significant until the delayed follow-up, conducted more than one year after the intervention ended. This pattern suggests that a behavior change preceded the change in weight gain. Moreover, the sustained effects in BMI category suggest that the adolescents in the intervention group made long lasting changes in their behavior.

Percent Body Fat

Although percent body fat (measured by DEXA) declined among intervention group adolescents and increased among control adolescents, the overall group difference over time was marginal. The pattern observed for control group adolescents follows the expected trend, given the associated rise in overweight observed among control adolescents. Among intervention adolescents, percent fat decreased over time while BMI category remained constant, suggesting that these adolescents not only were protected against becoming overweight through exposure to the intervention, but also experienced a slight decline in adiposity.

The gender differences in fat free mass related to the intervention suggest that males in the intervention group experienced an increase in body tissues not containing fat, such as skeletal muscle. Although there were no gender-related differences in physical activity, measured by accelerometry, adolescent males often express a desire for a muscular body size. (38) and respond relatively well to interventions based on physical activities. (39) One possibility is that intervention males engaged in weight bearing activities that increased fat free mass, but were not detected by accelerometry.

Physical Activity

At the post-intervention follow-up, the intervention protected the heaviest adolescents from the decline in physical activity experienced by the control group adolescents. During the following year, the differences between the intervention and control groups declined, suggesting that the effects of the 12-session intervention were not sustained and a booster may be helpful in retaining the intervention effects.

The decline in physical activity among control group members is consistent with national findings that rates of physical activity decline during adolescence. (40 2000, 41). Although at the post-intervention evaluation, we found significant differences favoring the heaviest youth within the intervention group, the intervention effects represented maintenance of the status quo, not an increase in physical activity. The inverse relation between body size and physical activity has been well documented among early adolescents. (42) One possibility is that the heaviest adolescents, those most likely to experience a decline in physical activity, benefited from the individualized support of the mentored intervention and were able to sustain their prior levels of physical activity.

A strength of the current investigation is the reliance on accelerometry to measure physical activity. Many previous studies have relied on self-report recall to measure physical activity. However, self-reported physical activity is notoriously unreliable (14). The recommendations for adolescents are 60 minutes of moderate/vigorous physical activity daily. (43), yet nationally most adolescents are not meeting this goal. PEPA captures time spent in light (e.g., light walking and "shooting around" while playing basketball), moderate, and vigorous activities. Although the participants in this study were engaging in an average of 90 minutes of PEPA, it is not clear whether they were meeting national guidelines for moderate/vigorous physical activity.

Snacks and Desserts

By the delayed follow-up, snack and dessert consumption decreased significantly more among intervention group adolescents, in comparison with control group adolescents. Snack consumption was targeted in the intervention. Not only do adolescents tend to snack frequently (44), but snacks are often high in energy density and fat. However, the data linking snacks to weight status among adolescents is controversial. Although snack consumption has been linked to weight status in some studies, (45) other studies have reported no association between snack consumption and weight status, {Phillips, 2004} suggesting that snacks should be clearly defined and examined in the context of overall dietary intake and physical activity. Although we did not find other intervention effects related to diet, the sample as a whole reported declines in calories, fat, and fibers over time. However, some caution is warranted because children tend to underreport their dietary intake. (46).

Home Environment

Conducting the intervention in the homes and communities enabled the mentors to help the adolescents transfer skills to their personal environments. Adherence to the intervention was positive in that over half of the adolescents in the intervention group participated in at least 10/12 sessions. However, the mentors often had to make multiple attempts to complete a visit. School, family, and personal activities often interfered with participation.

In spite of the adoption of health-promoting behaviors, the adolescents in this sample remain at significant risk for obesity. Not only are they low-income and minority, but three-quarters of the adolescents have mothers who are overweight or obese. The home food environment is strongly related to adolescents' dietary consumption. (20, 47) Adolescents who live in homes that stock high fat foods or who have mothers who frequently consume snacks and take-out foods are likely to adopt obesity-promoting dietary patterns. (47)

Growth History

We included children who had a history of growth deficiency and catch-up to examine whether their early growth history was related to adolescent weight status and body composition or to response to the intervention. We did not find any direct or indirect effects of early growth history. Most children had growth indices within normal by 6 years of age. (24) These findings suggest that temporary postnatal growth faltering among children born at term without other medical complications does not have long-term effects on their response to environmental interventions directed at diet, physical activity, and weight gain.

B. Explanation of study limitations

Methodological Considerations

There are several methodological limitations that should be considered in interpreting the findings. First, the sample was comprised of low-income, urban, African-American adolescents. Although the sample is at risk for excessive weigh gain during adolescence, generalizability of the findings is limited and the findings should be replicated. Second, although accelerometry provides an objective measure of movement, it does not capture weight-bearing activities and does not yield information on the type of physical activity. Finally, in spite of implementing a manualized intervention with weekly supervision, there was variability in the skills and attentiveness of the mentors and in the reach and acceptance of the intervention. Subsequent analyses are necessary to examine individual variability related to implementation variability.

C. Comparison with findings of other studies

The findings are consistent with other intervention trials demonstrating the difficulty of modifying growth trajectories in children. Yet, the findings are encouraging in that they were sustained over two years, suggesting that the participants altered their behavior.

D. Possible application of findings to actual MCH health care delivery situations (including recommendations when appropriate)

A one-on-one, 12-week health promotion, obesity prevention program delivered to low-income, urban adolescents in their homes and communities by college mentors was effective in preventing an increase in BMI category, in preventing a decline in physical activity among the heaviest adolescents, in enhancing fat free mass among males, and in reducing the intake of snacks and desserts. With the exception of the changes related to physical activity, the effects of the intervention were retained for one year after the implementation of the intervention, illustrating that the effects of obesity prevention trials may not be detected at the close of the intervention and that the intervention led to sustainable behavior changes.

E. Policy implications

Provide access to theory-based health promotion opportunities. Do not expect health promotion to lead to reductions in BMI or increases in physical activity. The most optimal outcome in this study was avoiding the increase in BMI and decrease in physical activity observed in the control group. Interventions that rely on pre- and post-tests are unlikely to be able to demonstrate effectiveness.

F. Suggestions for further research

A next step is to examine the mechanisms underlying the effectiveness of the intervention and to introduce the principles of *Challenge!*, including goal-setting and college mentors, into an after-school group setting.

Grant has been funded by NICHD to conduct a multi-level intervention of Challenge to prevent obesity and promote healthy diet and physical activity among 6th and 7th grade girls through an after-school program.

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VI. List of products (peer reviewed articles, books, chapters in books, master and doctoral dissertations, conference presentations, etc.).

1. Dissertations:

   Sonia Arteaga (2006) Obesity prevention among adolescents. University of Maryland Baltimore County, Department of Psychology

   Erin Hager, Familial Determinants of Physical Activity Behavior Change Among Urban African American Adolescents. Center for Human Nutrition, Department of International Health, Johns Hopkins Bloomberg School of Public Health

2. Publications

Mitola, A.L., Papas, M.A., Li, K. Fusillo, L. & Black, M. M. (2007). Agreement with satisfaction in adolescent body image between female caregivers and teens from a low-income African American community Journal of Pediatric Psychology, 31, 42-51.

Snitker, S., Le, K. Y., Hager, E. R., Caballero, B., Black, M.M. (2007). Relation between physical activity and body composition on glucose homeostasis in a community sample of adolescents. Archives of Pediatric and Adolescent Medicine, 161, 677-683.

Le, K. & Black, M. M. (2005). Pediatric obesity. In C. B. Fisher & R. M. Lerner (Eds.), Applied Developmental Science: An Encyclopedia of Research, Policies, and Programs. (pp. 755-757). New Bury, CA: Sage Publications.

Arteaga, S. & Black, M. M. (2005). Adolescent females, physical activity. In C. B. Fisher & R. M. Lerner (Eds.), Applied Developmental Science: An Encyclopedia of Research, Policies, and Programs. (pp. 19-21). New Bury, CA: Sage Publications.

Black, MM. Hager E, Shebl F. et al. (under review). Challenge!: A Mentorship Model of Health Promotion and Overweight Prevention Among Urban, African-American Adolescents.

3. DVD

Challenge Me! A music rap DVD available from Video Press, University of Maryland.

4. Report

Challenge Intervention – Home-Based Format – available in PDF files on CD.

Table 1: Baseline demographics of the participants by intervention status

	Intervention Mean (SD) or n(%)	**Control** Mean (SD) or n(%)	**P value**
	n=121	**n=114**	
Adolescent Demographics			
Age (years)	13.2(1.02)	13.3(1.04)	ns [a]
Education (years)	7.2(1.3)	7.2(1.2)	ns [a]
Gender (% Female)	62(51.2%)	54(47.4%)	ns [b]
Race/Ethnicity (% Non-Hispanic Black)	118(97.5%)	110(96.5%)	ns [b]
% overweight or obese (BMI $\geq$ 85th percentile)	54(44.6%)	36(31.6%)	0.040 [b]
Caregiver Demographics			
Age (years)	34.4 (8.5)	40.7 (9.5)	ns [a]
Gender (% Female)	113(94.2%)	105(95.9%)	ns [b]

Relation to teen (% biological mothers)	104(86.0%)	91(79.8%)	ns [b]
% overweight or obese (BMI $\geq$ 25kg/m^2)	92(76.7%)	86(76.1%)	ns [b]
Socio-Economic Status (% Living below the federal poverty line)	65(59.1%)	55(52.9%)	ns [b]
Education (% with high school diploma or GED)	90(74.4%)	86(75.4%)	ns [b]
% Female-led single parent households (% with no male adult present)	72(60.0%)	70(61.4%)	ns [b]

[a] *ANOVA*
[b] *Chi-square test*

Table 2: Anthropometry and body composition scores by intervention status for baseline and two post-intervention follow-up evaluations

	Baseline		**Post-intervention**		**Group difference at post-intervention**		**Delayed follow-up**		**Group difference at delayed follow-up**		**Time by intervention interaction**	
	Intervention N=121 Mean (SD)	Control N=114 Mean (SD)	Intervention N=91 Mean (SD)	Control N=93 Mean (SD)	χ^2	**p-value**	Intervention N=89 Mean (SD)	Control N=90 Mean (SD)	χ^2	**p-value**	χ^2	**p-value**
Anthropometry												
BMI z-score	0.76 (1.23)	0.59 (1.11)	0.73 (1.16)	0.61 (1.14)	**0.04**	**0.841**	0.77 (1.14)	0.65 (1.14)	**0.02**	**0.884**	**ns**	**ns**
BMI $\geq$ 85th percentile N (%)	54 (44.63)*	36 (31.58)*	36 (39.56)	32 (34.41)	**0.94**	**0.332**	35 (39.33)	38 (42.70)	**7.68**	**0.006**	**4.73**	**0.030**
Body Composition												
Total percent body fat (BIA)	24.92 (12.47)	23.64 (12.40)	25.70 (11.93)	24.29 (12.25)	**0.04**	**0.840**	24.88 (12.25)	24.35 (12.64)	**0.65**	**0.419**	**ns**	**ns**
Total percent body fat (DEXA)	27.20 (10.18)	24.47 (11.08)	25.76 (11.36)	24.20 (11.07)	**0.63**	**0.429**	25.00 (10.97)	25.62 (12.07)	**1.04**	**0.307**	**3.45**	**0.063**
Fat mass (Kg) (DEXA)	17.92 (10.47)	15.37 (11.79)	17.93 (12.01)	16.05 (11.94)	**0.80**	**0.371**	18.18 (12.08)	18.08 (12.78)	**0.25**	**0.617**	**ns**	**ns**
Fat free mass (Kg) (DEXA)[&]	43.17 (9.30)	42.87 (8.37)	45.79 (97.82)	42.87 (8.37)	**2.47**	**0.116**	48.85 (10.55)	46.56 (8.92)	**8.08**	**0.005**	**ns**	**ns**

**Intervention and control significantly differ at baseline ($p<0.05$)*
[&]Significant change over time $x^2=6.47$, p-value 0.011

Table 3: Physical activity (assessed via accelerometry) by intervention status for baseline, post-intervention, and delayed follow-up evaluations

	Baseline		**Post-intervention**		**group difference at post-intervention**		**Delayed follow-up**		**Group difference at delayed follow-up**		**Time by intervention interaction**	
	Intervention N=121 Mean (SD)	Control N=114 Mean (SD)	Intervention N=91 Mean (SD)	Control N=93 Mean (SD)	χ^2	**p-value**	Intervention N=89 Mean (SD)	Control N=90 Mean (SD)	χ^2	**p-value**	χ^2	**p-value**
Physical activity												
Log average total physical activity counts	6.31 (0.26)	6.34 (0.27)	6.27 (0.31)	6.26 (0.35)	**1.35**	**0.245**	6.24 (0.34)	6.28 (0.30)	**0.00**	**0.960**	**ns**	**ns**
Minutes per day of play equivalent physical activity (PEPA)	90.93 (38.31)	95.20 (43.77)	87.77 (45.96)	88.93 (50.19)	**0.59**	**0.443**	89.19 (47.99)	92.32 (44.99)	**0.12**	**0.727**	**ns**	**ns**
Minutes per day of play equivalent physical activity (PEPA) for adolescents with baseline BMI $\geq$ 85th percentile[&]	81.84 (32.62) n=50	86.50 (38.94) n=34	84.59 (48.68) n=35	66.19 (39.30) n=29	**5.57**	**0.018**	82.08 (49.08) n=31	75.03 (31.77) n=29	**1.06**	**0.304**	**ns**	**ns**

**Intervention and control significantly differ at baseline (p<0.05)*
[&]Significant change over time x^2=4.82, p-value 0.028

Table 4. Food frequency dietary variables by intervention status for baseline, post-intervention, and delayed follow-up

	Baseline		**Post-intervention**		**Group difference at post-intervention**		**Delayed follow-up**		**Group difference at delayed follow-up**		**Time by intervention interaction**	
	Intervention N=102	Control N=98	Intervention N=72	Control N=75	χ^2	**p-value**	Intervention N=80	Control N=79	χ^2	**p-value**	χ^2	**p-value**
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)			Mean (SD)	Mean (SD)				
Total kilocalories (kcals)*	2624(1192)	2539 (1074)	2257 (955)	2267 (1042)	**0.07**	**0.787**	2019 (965)	2078 (953)	**0.99**	**0.320**	**ns**	**ns**
Total dietary fat (gms)	94.8 (46.8)	93.8 (41.1)	81.7 (38.5)	82.2 (39.8)	**0.36**	**0.551**	74.3 (36.3)	76.02 (35.8)	**0.64**	**0.424**	**ns**	**ns**
Saturated fat (gms)	32.9(16.1)	32.8 (14.9)	28.6 (13.9)	28.3 (14.4)	**0.29**	**0.592**	26.1 (13.2)	26.5 (12.3)	**0.62**	**0.430**	**ns**	**ns**
Fiber (gms)*	19.2 (10.2)	17.6 (8.9)	17.1 (8.7)	17.2 (10.4)	**0.00**	**0.993**	15.2 (8.8)	15.2 (8.8)	**0.14**	**0.705**	**ns**	**ns**
Calcium (mgs)	1137 (605)	1095(557)	943 (472)	892 (504)	**0.24**	**0.626**	881 (530)	855 (436)	**0.00**	**0.982**	**ns**	**ns**
Fruits (servings/day)	1.3 (0.99)	1.08 (0.91)	1.1 (0.9)	1.3 (1.3)	**0.63**	**0.428**	1.0 (0.8)	1.0 (0.9)	**0.29**	**0.593**	**ns**	**ns**
Vegetables (servings/day)	2.1 (1.7)	1.6 (1.2)	1.8 (1.4)	1.6 (1.8)	**0.01**	**0.909**	1.7 (1.6)	1.6 (1.4)	**0.04**	**0.847**	**ns**	**ns**
Snacks and desserts (servings/day)[&]	4.5 (3.3)	4.4 (3.6)	3.6 (2.7)	4.1 (3.5)	**2.41**	**0.120**	2.96 (2.3)	3.5 (2.5)	**4.02**	**0.045**	**ns**	**ns**
Milk (servings/day)	0.90 (1.1)	0.87 (1.1)	0.84 (1.0)	0.73 (0.94)	**0.04**	**0.836**	0.63(0.88)	0.8 (0.97)	**0.65**	**0.419**	**ns**	**ns**
Non-diet soda (servings/day)	0.74 (0.72)	0.73 (0.69)	0.58 (0.62)	0.59 (0.64)	**0.12**	**0.733**	0.49 (0.6)	0.61 (0.66)	**3.13**	**0.077**	**ns**	**ns**
Fried foods (servings/day)	0.75 (0.39)	0.68 (0.49)	0.57 (0.39)	0.69 (0.51)	**3.15**	**0.076**	0.59 (0.35)	0.71 (0.48)	**1.46**	**0.226**	**ns**	**ns**

!Intervention and control significantly differ at baseline ($p<0.05$)
[&]Significant change over time $x^2=4.60$, p-value 0.032
**Calories over time ($F=6.91$, $p=0.009$) *Fiber over time ($F=6.67$, $p=0.011$) *Total fat over time ($F=4.21$, $p=0.040$)*