Published in final edited form as:

J Pediatr Endocrinol Metab. 2012 ; 25(0): 79–82. doi:10.1515/jpem.2011.386.

Effects of a multicomponent wellness intervention on dyslipidemia among overweight adolescents

Olga T. Hardy^{1,*}, Jean Wiecha², Albert Kim², Carlos Salas², Rayna Briceno³, Kwesi Moody³, Joan Becker⁴, Greer Glazer², Carol Ciccarelli¹, Ling Shi², and Laura L. Hayman²

¹Department of Pediatrics, University of Massachusetts Medical School, Worcester, MA 01605, USA

²College of Nursing and Health Sciences, University of Massachusetts, Boston, MA 02125, USA

³Dorchester Academy, Boston, MA 02124, USA

⁴Office of Academic Support Services and Undergraduate Studies, University of Massachusetts, Boston, MA 02125, USA

Abstract

Behavioral changes are the first line of treatment for dyslipidemia in adolescents, but outcome data on the effectiveness of this approach are inconsistent. This study aims to assess the effect of a 13-week multicomponent wellness intervention program, which included weekly nutrition classes and structured cardiovascular, flexibility, and strength training on dyslipidemia in nine overweight/obese [body mass index (BMI) ≥85th percentile] and nine lean (BMI <85th percentile) adolescents. Clinical measurements and lipid profile assessment were performed before and after the intervention. At the completion of the study, the overweight/obese adolescents demonstrated a 15% increase in high-density lipoprotein cholesterol (HDL-C) levels (mean, 47±8 vs. 54±5 mg/dL), whereas there was no improvement in BMI or other measurements. The participants in the lean group showed no change in their anthropometric and serum parameters. A multicomponent wellness intervention resulted in a significant increase of cardioprotective HDL-C levels, which have been associated with coronary health in adulthood.

Keywords

exercise; dyslipidemia; high-density lipoprotein cholesterol; metabolic syndrome; obesity

Introduction

Epidemiologic studies suggest that atherosclerotic processes begin in childhood and are associated with abnormal lipid levels, including a low concentration of high-density lipoprotein cholesterol (HDL-C) (1, 2). Behavioral and lifestyle changes are the first line of treatment for dyslipidemia in adults (3) and recommended as the cornerstone of treatment

for children and adolescents (4, 5); however, minimal lipid profile outcome data are available in adolescents (6).

The primary goal of this pilot study was to assess the effect of a 13-week multicomponent wellness intervention program on dyslipidemia in lean and overweight/obese adolescents. For this purpose, we conducted a substudy of Fit2Lead, which is a longitudinal behavioral intervention that engages high school students in physical activities, educational workshops, academic classes, and training toward becoming future role models and mentors. In our substudy, we evaluated the lipid profile of participants before and after participation in the intervention. We hypothesized that at the end of the intervention, higher activity level would lead to an improvement in lipid levels, especially HDL-C, which is known to increase with consistent exercise (6).

Materials and methods

Participants

Participants were recruited from Dorchester Academy, a Boston inner-city neighborhood public high school where 97.5% of students are non-white and most are from low-income families. Criteria for participation included academic risk due to behavioral issues or poor performance on the Massachusetts Comprehensive Assessment System test. The study was approved by the University of Massachusetts Boston institutional review board, and written informed assent and consent were obtained from participants and parents, respectively.

Fit2Lead description

The Fit2Lead pilot study consisted of a 13-week intervention that included a fitness and leadership training program. The program was designed to promote academic achievement, encourage fitness, improve self-concept, and provide work experience. The fitness intervention was delivered at the GoKids facility, an innovative youth fitness, research, and training center on the University of Massachusetts Boston campus. This comprehensive resource includes a full range of cardio equipment, weight machines, free weights, and a game area that accommodates active participation in gross motor play and electronic exergames. During the first 5 weeks, the program consisted of exercise education twice (15 min each), exercise twice (45 min each), and nutrition education twice (30 min each) per week. The remaining 8 weeks of the program included exercise education (30 min each), exercise four times (60 min each) per week, and nutrition education two times (30 min each) per week. The exercise component of the program was led by an exercise physiologist and consisted of warm-up activities, stretching, weight training, strength training, cardiovascular routines, core training, and circuit training. The nutrition education portion of the program was facilitated by the University of Massachusetts Extension's Supplemental Nutrition Assistance Program Education program and focused on the food pyramid, healthy snacks, carbohydrate counting, and the importance of protein, fat, fruits and vegetables, milk, sugar beverages, breakfast, and appropriate serving sizes.

Measures

Participants' demographic data and pubertal staging were collected at baseline. Tanner staging was assessed using a self-assessment questionnaire, which has a high correlation with physical examination (7). Outcome measures were obtained at baseline and 13 weeks. Weight was measured using a Tanita scale (model BC418, Japan), and height was measured using a stadiometer (Shorr Board Stadiometer, Olney, MD, USA). Body mass index (BMI) was determined by calculating the weight in kilograms divided by the height in meters squared. Overweight/obesity was established using BMI 85th percentile for age and gender according to the Centers for Disease Control and Prevention guidelines (8). Percentage body fat was determined using a body fat analyzer (Tanita model BC418, Japan). Blood pressure was measured with a sphygmomanometer and identified as elevated according to the National Heart, Lung, and Blood Institute guidelines (8). Weight, height, and blood pressure were measured three times, and the results were averaged for analysis.

Serum was obtained after an overnight fast for measurement of total cholesterol, HDL-C, low-density lipoprotein cholesterol (LDL-C), and triglyceride levels. For most participants, plasma lipid levels were measured with a spectrophotometer (SYNCHRON LX Systems, Beckman Coulter, Inc., Brea, CA, USA). Blood samples were collected in cell preparation tubes (Becton-Dickinson, Franklin Lakes, NJ, USA), which contain anticoagulant. Plasmas prepared without anticoagulant served as a standard for determining the dilution produced by the anticoagulant. The lipid results were multiplied by a factor of 1.3 to correct for sample dilution. Three participants refused a blood draw and postintervention blood draw, and cholesterol data were obtained using Cholestech LDX[®] System (Inverness Medical, UK).

Questionnaire

Participants completed several questionnaires preintervention and postintervention, assessing self-efficacy, nutritional habits, and involvement in physical activity. For the analysis in this substudy, we used responses from the following question related to physical activity: "On average, how many days during a typical week are you physically active for a total of at least 60 min per day?"

Data management

Differences between the lean and overweight/obese groups in baseline measures were tested using Student's t-test for continuous variables and Fisher's exact test for categorical variables. The effect of the intervention on outcome measures was determined using paired t-test from data obtained at baseline and 13 weeks. A t-test of the difference between pretest and posttest measures was used to assess for a differential effect of the intervention between the lean and overweight/obese groups. For all of the analyses, the results were considered significant at $p \leq 0.05$.

Results

Participants

Of the 27 adolescents screened for eligibility, three declined to participate. The remaining 24 participants enrolled in the Fit2Lead intervention, but four dropped out (three because of conflicts with work schedule and one moved away from the area) and two participants did not provide blood samples. There were no significant differences on variables measured at baseline (preintervention) between those retained and those lost to follow-up.

Of the remaining 18 participants, 13 (72%) were female, and the mean age of the cohort was 16 ± 0.9 years (Table 1). The majority of the participants was African American. Using BMI percentiles for age and gender (8), we divided the cohort into two groups: overweight/obese ($n=9$) and lean ($n=9$). The overweight/obese and lean participants were of similar age, gender, ethnic group, and Tanner pubertal stage. Overweight/obese participants showed significantly elevated BMI and percentage body fat as compared with lean participants. Four students in this group were overweight (85th percentile<BMI<95th percentile) and five were obese (BMI $\geq$ 95th percentile). There was no statistical significance between the group differences in the components of the lipid profile and systolic and diastolic blood pressure. However, the overweight/obese participants tended to have higher LDL-C and lower HDL-C levels.

Effects of intervention

At the end of the 13-week intervention, the overweight/obese participants exhibited a greater increase in HDL-C levels than their lean peers (Table 1). The overweight/obese participants also demonstrated minimal increases in BMI, BMI percentile, percentage body fat, total cholesterol level, triglyceride level, and systolic blood pressure. There were no differences observed between preintervention and postintervention parameters in the lean cohort. At postintervention, the overweight/obese participants reported an increase in the frequency of obtaining 60 min/day of physical activity, from 1.8 to 3 days per week ($p=0.09$). In contrast, the frequency of physical activity did not change in the postintervention survey for the lean participants. There was no differential effect of the intervention on change in the outcome parameters between the lean and overweight/obese groups (data not shown).

Discussion

The goal of this substudy was to assess metabolic benefits of a multicomponent wellness intervention in an adolescent population. Exercise and nutrition education coupled with 30–60 min of activity per day, 2–4 days per week, for 13 weeks resulted in increased HDL-C levels among overweight and obese adolescents. Low concentrations of HDL-C show a significant correlation with the size of atherosclerotic lesions present in autopsies obtained from children (1, 9). Thus, an increase in HDL-C in childhood, if maintained, could potentially lower the lifelong risk of cardiovascular disease in adulthood.

Our study indicates a beneficial effect of supervised physical activity on HDL-C, which is consistent with other observational and intervention studies (6, 10). However, a unique feature of our results is the lack of weight loss after the intervention, which suggests that

weight loss does not play a major role in mediating the beneficial effect of activity on improvement in HDL-C. Our intervention did not alter triglyceride, total cholesterol, or LDL-C, likely because most of the participants had normal levels at baseline.

Participation in the intervention yielded a minimal increase in BMI, percentage body fat, total cholesterol, triglycerides, and systolic blood pressure in the overweight/obese cohort. Although these findings were statistically significant, it is unlikely that they represent true clinical significance. In addition, it has been previously reported that children gain more weight during summer months than winter months, a phenomenon that has been thought to contribute to lack of success in pediatric weight control programs (11).

Limitations of this study include the small sample size with participants drawn from one school in one urban geographic location and lack of a control group. The inclusion of a control group that did not participate in the wellness intervention may have revealed an even greater increase in BMI and other metabolic parameters. The majority of our participants was low-income, inner-city minority youth, which may limit the generalizability of the Fit2Lead intervention in rural populations. However, its strengths are implementation during the school year and summer months, a supervised exercise component, and a leadership training component, which may have contributed to improved self-confidence and empowerment, allowing the participants to make beneficial behavioral changes.

We have shown that a multicomponent program that provides nutrition education, exercise skills, and activity can raise cardioprotective HDL-C levels independent of a decrease in BMI. Two key elements that contribute to the success of any program include supervised activity sessions and long-term follow-up. Future studies will assess the optimal dose and duration of exercise as well as the sustained effects of the intervention on HDL-C, other indicators of cardiometabolic health, and indices of adiposity.

Acknowledgments

This study was partially supported by a grant from the Life Sciences Moment Fund (OTH, JLW, and LLH), University of Massachusetts Medical Center.

References

1. Newman WP III, Freedman DS, Voors AW, Gard PD, Srinivasan SR, et al. Relation of serum lipoprotein levels and systolic blood pressure to early atherosclerosis: the Bogalusa Heart Study. *N Engl J Med.* 1986; 314:138–44. [PubMed: 3455748]
2. Ross R. The pathogenesis of atherosclerosis: an update. *N Engl J Med.* 1986; 314:488–500. [PubMed: 3511384]
3. Executive summary of the third report of the National Cholesterol Education Program (NCEP) Expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult treatment panel III). *J Am Med Assoc.* 2001; 285:2486–97.
4. Daniels SR, Greer FR. Committee on Nutrition. Lipid screening and cardiovascular health in childhood. *Pediatrics.* 2008; 122:198–208. [PubMed: 18596007]
5. Barlow SE. Expert Committee. 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. [PubMed: 18055651]
6. Strong WB, Malina RM, Blimkie CJ, Daniels SR, Dishman RK, et al. Evidence-based physical activity for school-age youth. *J Pediatr.* 2005; 146:732–73. [PubMed: 15973308]

7. Taylor SJ, Whincup PH, Hindmarsh PC, Lampe F, Odoki K, et al. Performance of a new pubertal self-assessment questionnaire: a preliminary study. *Paediatr Perinat Epidemiol.* 2001; 15:88–94. [PubMed: 11237120]
8. Centers for Disease Control and Prevention, National Center for Health Statistics. [Accessed on August 1, 2011.] CDC growth charts: United States. May 30. 2000 Available at: <http://www.cdc.gov/growthcharts/>
9. McGill HC Jr, McMahan CA, Malcom GT, Oalman MC, Strong JP. Effects of serum lipoproteins and smoking on atherosclerosis in young men and women. The PDAY Research Group. Pathobiological determinants of atherosclerosis in youth. *Arterioscler Thromb Vasc Biol.* 1997; 17:95–106. [PubMed: 9012643]
10. Akimoto-Gunther L, Hubler M, Santos M, Carolino I, Sonoo N, et al. Effects of re-education in eating habits and physical activity on the lipid profile of obese teenagers. *Clin Chem Lab Med.* 2002; 40:460–2. [PubMed: 12113288]
11. Gillis L, McDowell M, Bar-Or O. Relationship between summer vacation weight gain and lack of success in a pediatric weight control program. *Eat Behav.* 2005; 6:137–43. [PubMed: 15598600]

Table 1

Baseline and postintervention changes in body composition, cardiovascular parameters, and questionnaire responses.

	Overweight/obese (n=9)		Lean (n=9)	
	Preintervention	Postintervention	Preintervention	Postintervention
Female, no., %	7 (78)	–	6 (67)	–
Ethnic group, no., %				
African American	9 (100)	–	8 (89)	–
Hispanic	0	–	1 (11)	–
Age, year	16.3±1.1	–	16±0.7	–
Tanner stage, no., %				
3	1 (11)	–	2 (22)	–
4	2 (22)	–	2 (22)	–
5	6 (67)	–	5 (56)	–
BMI, kg/m ²	30.2±4.4 ^a	31±4.5 ^b	21±1.9	21±2.4
BMI, %	93.6±4.9 ^a	94.8±3.7 ^c	51.6±21.3	51.4±25.8
Percentage body fat	34.8±6.4 ^a	36.5±7.3 ^c	21.2±5.9	23.6±5.6
Cholesterol, mg/dL	138±23	152±33 ^c	136±27	156±37
Triglyceride, mg/dL	51±27	60±34 ^c	48±9	56±25
HDL, mg/dL	47±8	54±5 ^b	53±14	56±15
LDL, mg/dL	79±24	86±30	74±21	93±39
Systolic BP, mm Hg	115±9	121±11 ^c	109±8	112±8
Diastolic BP, mm Hg	74±8	72±5	74±8	73±4
No. of days per week engaged in vigorous physical activity	1.8±2	3±1.6	3±1.7	3.7±1.7

^a p<0.05 Compared with lean group at baseline.

^b p<0.01 Within group, compared with preintervention testing.

^c p<0.05 Within group, compared with preintervention testing.

BMI, body mass index; HDL, high-density lipoprotein; LDL, low-density lipoprotein; BP, blood pressure.