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Abstract

Epidemiologic studies suggest that atherosclerotic processes begin in childhood and are associated with abnormal lipid levels. 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 aimed to assess the effect of a 13-week multicomponent wellness intervention program on dyslipidemia in lean and overweight/obese adolescents enrolled at a public high school in Boston, Massachusetts. The intervention was conducted at a university-based youth fitness center where 9 overweight/obese adolescents (body mass index [BMI]≥85th percentile for age and sex) and 9 lean adolescents (BMI<85th percentile for age and sex) participated in weekly nutrition classes and structured cardiovascular, flexibility and strength training 2 times/week for 5 weeks, followed by up to 4 times/week for 8 weeks. Clinical measurements (BMI, percent body fat, blood pressure [BP]) and lipid profile assessment (total cholesterol [TC], high-density lipoprotein cholesterol [HDL-C], triglycerides [TG], and low-density lipoprotein cholesterol [LDL-C]) were performed at baseline and at completion of the intervention. At the completion of the study, the overweight/obese adolescents demonstrated a 15% increase in HDL-C levels (mean, 47 mg/dL vs 54 mg/dL) while there was no improvement in BMI, percent body fat, BP,TG, TC and LDL-C. 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 has been associated with coronary health in adulthood. The long-term effects of this intervention on indicators of cardiometabolic health and others like it require further study.

Background

- Atherosclerotic processes begin in childhood and are associated with abnormal lipid levels including a low concentration of high-density lipoprotein cholesterol (HDL-C)
- Behavioral and lifestyle changes are recommended as the cornerstone of treatment for dyslipidemia in children and adolescents; however minimal lipid profile outcome data are available in adolescents
- 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 (body mass index [BMI] > 85th percentile for age and sex) adolescents.
- We conducted a sub-study of Fit2Lead, which is a longitudinal behavioral intervention that engages high school students in physical activities, educational workshops, academic classes and training towards becoming future role models and mentors.
- In our sub-study we evaluated the lipid profile of participants before and after participation in the intervention.

HYPOTHESIS: High activity level will lead to an improvement in lipid levels, especially HDL-C which is known to increase with consistent exercise

Results

TABLE. Baseline and post-intervention changes in body composition, cardiovascular parameters and questionnaire responses

	Overweight/Obese (n=9)		Lean (n=9)	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Female, No. (%)	7 (78)		6 (67)	
Ethnic group, No. (%)				
African American	9 (100)		8 (89)	
Hispanic	0		1 (11)	
Age (yr)	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/m2)	30.2 ± 4.4*	31 ± 4.5^^	21 ± 1.9	21 ± 2.4
BMI %	93.6 ± 4.9*	94.8 ± 3.7^	51.6 ± 21.3	51.4 ± 25.8
% Body fat	34.8 ± 6.4*	36.5 ± 7.3^	21.2 ± 5.9	23.6 ± 5.6
Cholesterol (mg/dL)	138 ± 23	152 ± 33^	136 ± 27	156 ± 37
Triglyceride (mg/dL)	51 ± 27	60 ± 34^	48 ± 9	56 ± 25
HDL (mg/dL)	**47 ± 8**	**54 ± 5^^**	53 ± 14	56 ± 15
LDL (mg/dL)	79 ± 24	86 ± 30	74 ± 21	93 ± 39
Systolic BP (mm Hg)	115 ± 9	121 ± 11^	109 ± 8	112 ± 8
Diastolic BP (mm Hg)	74 ± 8	72 ± 5	74 ± 8	73 ± 4
Number of days per week engaged in vigorous physical activity	1.8 ± 2	3 ± 1.6	3 ± 1.7	3.7 ± 1.7

* P < 0.05 compared with lean group at baseline

^ P < 0.05 within group, compared with pre-intervention testing

^^ P < 0.01 within group, compared with pre-intervention testing

Fit2Lead

13 Week Intervention

Activity	Frequency	Time Interval
Weeks 1-5 (school year)		
Exercise education	2 X / week	15 minutes
Nutrition	2 X / week	30 minutes
Exercise	2 X / week	45 minutes
Weeks 6-13 (summer break)		
Exercise education	2 X / week	30 minutes
Nutrition	2 X / week	30 minutes
Exercise	4 X / week	60 minutes

Exercise education –fitness goals, proper technique for cardiovascular and strength training

Nutrition –food pyramid, healthy snacks, carbohydrate counting, sugar beverages, appropriate serving sizes, importance of breakfast

Exercise –warm-up activities, stretching, weight training, strength training, cardiovascular routines, core training, circuit training

Conclusions and Future Directions

- Exercise and nutrition education coupled with 30-60 minutes 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
- Increase in HDL-C in childhood, if maintained, could lower the lifelong risk of cardiovascular disease in adulthood.
- Lack of weight loss after the intervention suggests that weight loss does not play a major role in mediating the beneficial effect of activity on improvement in HDL-C.
- Leadership training component may have contributed to improved self-confidence and empowerment allowing the participants to make beneficial behavioral changes.
- Majority of participants were low-income, inner-city minority youth which may limit the generalizability of the Fit2Lead intervention in rural populations.
- Future studies will assess 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.

Materials/Methods

Participants

Participants were recruited from Dorchester Academy, a Boston inner-city neighborhood public high school with a high percentage of racially and ethnically diverse students from low income families. Criteria for participation included academic risk due to behavioral issues or poor performance on the Massachusetts Comprehensive Assessment System test (MCAS). 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.

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, fitness, improved self-concept and work experience. The fitness intervention was delivered at the GoKids facility, an innovative youth fitness, research and training center on the U Mass 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 electronic exergames. During the first 5 weeks, the program consisted of exercise education twice (15 minutes each), exercise twice (45 minutes each) and nutrition education twice (30 minutes each) per week. The remaining 8 weeks of the program included exercise education (30 minutes each), exercise 4 times (60 minutes each) per week and nutrition education 2 times (30 minutes 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 (SNAP-Ed) 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 (6). 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). 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 CDC guidelines (7). Percent 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 NHLBI guidelines (8). Weight, height and blood pressure were measured 3 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, and triglyceride. For most participants, plasma lipid levels were measured with a spectrophotometer (SYNCHRON LX Systems). Results were multiplied by 1.28 to account for the dilution factor. Three participants refused a blood draw, and post-intervention cholesterol data was obtained using Cholestech LDX® System (Inverness Medical).

Questionnaire

Participants completed several questionnaires pre- and post-intervention assessing self-efficacy, nutritional habits and involvement in physical activity. For the analysis in this sub-study 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 minutes 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 pre-test and post-test 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 ≤ 0.05.

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