Correlates of High-Density Lipoprotein Cholesterol in Black Girls and White Girls: The NHLBI Growth and Health Study

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ABSTRACT

To determine the correlates of serum high-density lipoprotein cholesterol (HDL-C) in 9- and 10-year-old girls, data were examined from 624 Black girls and 773 White girls. Black girls had, on average, 3.6 mg/dL higher levels than White girls. Each 10-mm increase in sum of skinfolds was associated with a decrease of 1.4 mg/dL; each unit increase in the tricep/suprailiac skinfold ratio was associated with an increase of 2 mg/dL; and each 10% increase in polyunsaturated fat intake was associated with an increase of 3.4 mg/dL. The associations of sedentary activity and sexual maturation with HDL were mediated by differences in adiposity. Interventions to decrease adiposity may be important for the primary prevention of heart disease in women. (*Am J Public Health.* 1995;85:1698–1702)

Introduction

High-density lipoprotein cholesterol (HDL-C) is inversely associated with the risk of coronary heart disease.[1] Because HDL-C levels in childhood may predict levels in adulthood,[2–4] identifying modifiable risk factors for low HDL-C levels in children may be important for the primary prevention of coronary heart disease. This paper examines the baseline correlates of HDL-C in 9- and 10-year-old girls enrolled in the National Heart, Lung, and Blood Institute (NHLBI) Growth and Health Study.

Methods

The NHLBI Growth and Health Study is a biracial, prospective study of obesity and cardiovascular risk factors in girls aged 9 and 10 years at baseline.[5] The study cohort, sampling design, and study methods are described elsewhere.[5] In brief, the study enrolled 1213 Black and 1166 White girls between January 1987 and May 1988 in three geographic sites: Richmond, Calif; Cincinnati, Ohio; and the Washington, DC, area. At the baseline visit, 1397 subjects (624 Blacks and 773 Whites) were available for multiple regression analysis after excluding the small number of girls who had entered menarche (65 Blacks and 20 Whites), premenarchal girls who had fasted for less than 12 hours or for whom blood samples were not available (363 Blacks and 265 Whites), and subjects with missing data on other variables used in modeling (161 Blacks and 108 Whites). Included and excluded subjects were generally comparable.

Anthropometric measurements were performed according to a common standardized protocol,[5] and questionnaires were used to assess level of parental education and household income.[5] Sexual maturation was assessed using a modification of the Tanner staging method[5–7]; Tanner-1 and Tanner >1 were classified as prepubertal and pubertal, respectively. A 3-day diet record was used to collect nutrition information.[8] Serum HDL-C levels were measured using standard techniques.[9]

Chi-square tests were used to compare categorical variables, t tests were used to compare continuous variables, and linear regression models were used to assess the relation of variables to HDL-C. Because sum of skinfolds (triceps, subscapular, and suprailiac) and body mass index were highly correlated ($r = .90$; $P < .001$), sum of skinfolds was chosen as the more direct measure of adiposity.[10] Television viewing was included in the multiple regression models because, after adjustment for race, an inverse association was found between television viewing and HDL-C ($P = .07$).

Results

Black girls were heavier, were more likely to have reached puberty, had a greater energy intake, and had higher levels of HDL-C than White girls ($P < .05$) (Table 1). In addition, Blacks came from families with lower household incomes and watched more television per week compared with Whites ($P < .001$).

Simple regression results are shown in Table 2. Variables associated with HDL-C include height, weight, body mass index, sum of skinfolds, tricep/suprailiac

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skinfold ratio, sexual maturation, and polyunsaturated fat intake ($P < .05$). Income level (medium vs low) was marginally associated with HDL-C ($P = .07$). To ascertain whether race modified these associations, interaction terms were added to regression models that included each independent variable and race. No significant interactions were found ($P > .10$).

To determine the effect of adiposity on these associations, four multivariate models were examined (Table 2). In model 1, income was no longer associated with HDL-C ($P > .10$) whereas television viewing and pubertal maturation remained inversely associated with HDL-C ($P < .05$ and $< .001$, respectively). Income was not associated with HDL-C after adjustment for race. After adjustment for tricep/suprailiac skinfold ratio (model 2) and sum of skinfolds (model 3), television viewing and pubertal maturation were no longer associated with HDL-C. Adjustment for both tricep/suprailiac skinfold ratio *and* sum of skinfolds (model 4) decreased the magnitude of the association of pubertal maturation with HDL-C even further. An additional model that included the ratios of polyunsaturated fat/saturated fat intake and polyunsaturated fat/monounsaturated fat intake as well as total fat intake revealed no significant associations between these variables and HDL-C ($P > .05$).

TABLE 1—Characteristics of the Study Subjects[a] from the NHLBI Growth and Health Study

	Black Girls		White Girls		
	No.	Mean ± SD	No.	Mean ± SD	*P*
High-density lipoprotein cholesterol (mg/dL)	785	55.3 ± 13.8	881	53.2 ± 11.4	<.001
Anthropometric measures					
Height, cm	783	142.8 ± 7.6	881	139.5 ± 7.1	<.001
Weight, kg	784	39.6 ± 11.2	881	35.0 ± 8.5	<.001
Body mass index, kg/m^2	783	19.2 ± 4.3	881	17.8 ± 3.2	<.001
Sum of skinfolds, mm	780	36.0 ± 21.4	876	32.6 ± 16.4	<.001
Tricep/suprailiac skinfold ratio	780	1.5 ± 0.5	877	1.6 ± 0.6	<.001
Dietary intake					
Energy intake, kcal/day	696	1856 ± 586	841	1798 ± 450	<.05
Carbohydrate, % kcal	696	49.9 ± 7.0	841	51.6 ± 6.7	<.001
Saturated fat, % kcal	696	13.3 ± 2.5	841	13.8 ± 2.6	<.01
Monounsaturated fat, % kcal	696	13.9 ± 2.4	841	13.0 ± 2.2	<.001
Polyunsaturated fat, % kcal	696	6.7 ± 2.3	841	5.8 ± 1.8	<.001
Activity					
Television watching, hours/week	755	36.4 ± 17.4	863	25.0 ± 14.4	<.001
Physical activity[b]					
Never or almost never, %	117	15.4	67	7.8	
Sometimes, %	307	40.5	337	39.4	
Usually or always, %	334	44.1	451	52.8	<.001
Sexual maturation stage					
Prepubertal, %	263	34.3	589	68.8	
Pubertal, %	503	65.7	267	31.2	<.001
Level of education of parents or guardians					
High school or less, %	234	29.9	156	17.7	
Some college, %	368	46.9	273	31.0	
College graduate, %	182	23.2	452	51.3	<.001
Pretax annual household income (1986)					
Less than $20 000	318	43.1	120	14.3	
$20 000–$39 999	229	31.0	273	32.5	
$40 000 or greater	191	25.9	448	53.3	<.001

[a]Unpaired *t* tests to compare means of Blacks and Whites; chi-square to compare proportions in physical activity, maturation stage, level of education, and annual income level.
[b]Response to the question "I am physically active."

Discussion

Race, adiposity, and body fat distribution are the most important correlates of HDL-C. These results agree with those of other studies, including the Bogalusa Heart Study and the Lipid Research Clinics Program Prevalence Study: Black children have higher HDL-C levels than White children,[11-19] and obesity is inversely associated with HDL-C.[19-25] Although we did not measure waist-to-hip ratio, an indicator of fat distribution that may be a correlate of HDL-C in adults,[26,27] we did find that the tricep/suprailiac skinfold ratio was associated with HDL-C.

Television viewing, a sedentary activity, is associated with childhood obesity,[28] an effect possibly mediated through decreased physical activity or increased energy consumption.[29-31] After controlling for differences in adiposity, television viewing was no longer associated with HDL-C. Our results are consistent with the view that it is not television viewing per se, but rather the associated differences in adiposity that accompany television viewing that are the proximate correlates of HDL-C.

Income level was not an independent correlate of HDL-C. In some studies of adults, race appears to modify the association between socioeconomic status and HDL-C; socioeconomic status is directly correlated with HDL-C in Whites,[25,27,32,33] but is inversely correlated with HDL-C in Black men[25,32,34-36] and, perhaps, Black women.[37] We were unable to confirm these findings but cannot exclude the possibility that this interaction might have been apparent in a larger study.

Levels of HDL-C are relatively constant during adolescence in girls and may reflect the balance between the effects of estrogen to increase and progesterone to decrease HDL-C.[38] HDL levels did not differ between pubertal and prepubertal girls after controlling for sum of skinfolds and tricep/suprailiac skinfold ratio, and this is consistent with the hypothesis that maturational differences in adiposity affect HDL-C.

Polyunsaturated fat intake was associated with higher HDL-C levels ($P < .05$). Although some experimental studies have reported that polyunsaturated fat consumption lowers HDL-C,[39-41] this has not been observed uniformly.[42-45] Our findings concur with two reviews that conclude that all fatty acids tend to raise HDL-C when they replace carbohydrates.[46,47]

TABLE 2—Associations of Anthropometric, Sociodemographic, Dietary, and Physical Measures with Serum Level of High-Density Lipoprotein Cholesterol (HDL-C) (mg/dL)[a] in Black Girls and White Girls

	Simple Regression Models: Slope (95% CI)[b]	Multiple Regression Models: Slope (95% CI)[b]			
		Model 1	Model 2	Model 3	Model 4
Race (Black vs White)	2.09 (0.88, 3.31)	3.62 (2.05, 5.19)	3.81 (2.26, 5.36)	3.55 (2.02, 5.08)	3.62 (2.10, 5.15)
Anthropometric measures					
Height, cm	−0.16 (−0.24, −0.08)				
Weight, kg	−0.30 (−0.35, −0.24)				
Body mass index, kg/m²	−0.84 (−1.00, −0.69)				
Sum of skinfolds, mm	−0.18 (−0.21, −0.15)			−0.17 (−0.20, −0.13)	−0.14 (−0.18, −0.10)
Tricep/suprailiac skinfold ratio	4.21 (3.07, 5.35)		4.39 (3.11, 5.67)		2.02 (0.59, 3.45)
Dietary intake					
Energy intake, 100 kcal/day	−0.03 (−0.15, 0.10)				
Carbohydrate, % kcal	−0.06 (−0.16, 0.03)				
Saturated fat, % kcal	0.02 (−0.23, 0.27)				
Monounsaturated fat, % kcal	0.16 (−0.11, 0.43)				
Polyunsaturated fat, % kcal	0.36 (0.05, 0.67)	0.34 (0.01, 0.67)	0.38 (0.06, 0.70)	0.31 (−0.01, 0.63)	0.34 (0.02, 0.65)
Activity					
Television watching, 10 hours/wk[c]	−0.09 (−0.46, 0.27)	−0.49 (−0.91, −0.06)	−0.37 (−0.78, 0.05)	−0.26 (−0.68, 0.15)	−0.25 (−0.66, 0.17)
Physical activity					
Sometimes vs never	−0.69 (−2.76, 1.39)				
Usually vs never	0.54 (−1.49, 2.57)				
Sexual maturation stage					
Pubertal vs prepubertal	−1.25 (−2.47, −0.02)	−2.13 (−3.56, −0.71)	−1.31 (−2.74, 0.12)	−0.56 (−1.98, 0.87)	−0.41 (−1.84, 1.01)
Level of education of parents or guardians					
Some college vs no college	0.08 (−1.52, 1.67)				
College graduate vs some college	0.33 (−1.06, 1.72)				
Income[d]					
Medium vs low	−1.49 (−3.12, 0.13)	−0.53 (−2.33, 1.26)	−0.66 (−2.43, 1.11)	−0.61 (−2.35, 1.14)	−0.66 (−2.40, 1.08)
High vs medium	0.61 (−0.87, 2.09)	1.46 (−0.11, 3.03)	1.46 (−0.10, 3.01)	1.40 (−0.13, 2.93)	1.38 (−0.15, 2.91)
		R^2 = .03	R^2 = .06	R^2 = .09	R^2 = .09

[a]Multivariate models include selected variables significant at $P \leq .10$ in univariate analyses and are adjusted for clinical center.
[b]Indicates difference (and 95% confidence intervals [CIs]) in serum level of HDL-C (in mg/dL) per indicated unit of each variable. Each dichotomized variable was coded 1 vs 0.
[c]Included because $P = .07$ after adjustment for race.
[d]Low income ≤ $20 000/year; medium income = $20 000–$39 999/year; high income ≥ $40 000/year.

Our study had several limitations. Subfractions of HDL-C were not measured. Baseline data on tobacco and alcohol use, which are correlates of HDL-C in adolescents and adults, were not collected.[21,24,48,49] It is unlikely, however, that our participants at ages 9 and 10 years were large consumers of tobacco or alcohol. Lastly, most of the variability in HDL-C at this age remains unexplained. Our findings do, however, provide additional evidence that adiposity and body fat distribution are important correlates of HDL-C in children, and they suggest that associations of sexual maturation and sedentary activity with HDL-C may be mediated by differences in adiposity. □

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Aerobic Fitness, Blood Lipids, and Body Fat in Children

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ABSTRACT

This study examined the association between aerobic fitness and serum cholesterol and the effects of controlling for gender, body composition, abdominal fat, and dietary saturated fat in 262 children. The 1-mile run was used to estimate fitness. Skinfolds were used in assessing body fat. Fit children had lower total cholesterol, low-density lipoprotein cholesterol, and triglyceride levels and higher high-density lipoprotein cholesterol levels than unfit children, except after adjustment for body fat and/or abdominal fat. Unfit children appear to be at an increased risk of unhealthy levels of serum cholesterol due primarily to increased levels of body fat. (*Am J Public Health.* 1995;85:1702–1706)

Introduction

Atherosclerosis has been shown to begin in infancy.[1] Results from the International Atherosclerosis Project identified the presence of fatty streaks in the aortas of many children by 3 years of age.[2] Moreover, fatty streaks observed in the coronary arteries of 10-year-olds have been found to be associated with adult arteriosclerosis.[3]

Research clearly shows that elevated serum lipid levels promote the development of atherosclerosis and are a principal cause of cardiovascular disease.[4–6] Because atherosclerosis can begin to develop in childhood, the early years of life are a good time to intervene to reduce the risk of cardiovascular disease.[7] Research indicates that regular physical activity and subsequent high levels of aerobic fitness can be a valuable method of intervention in the prevention and treatment of hypercholesterolemia in adults.[8–20] Unfortunately, the extent to which these lifestyle factors are associated with cholesterol levels in children is much less clear.

Research has shown that physical activity, sports participation, and training have favorable effects on both high-density lipoprotein (HDL) cholesterol and total/HDL ratio levels in children; however, results have been mixed depending on gender and age.[21–26] Results also have varied regarding training effects on total cholesterol.[22–24]

Although some cholesterol investigations have studied the extent to which blood lipid levels are related to physical activity and exercise in children, little research to date has examined the relation between measured aerobic fitness and blood lipids in children.[24] Yet, study of aerobic fitness and blood lipids is probably a more valid approach than measurement of self-reported physical activity and blood lipids,[8,27] particularly in children. Physical activity is usually a subjective measurement requiring accurate recall. Children's accuracy in reporting their physical activity is likely to be poor and may denote inaccurate perceptions.[8]

The purpose of this study was to determine the extent to which aerobic fitness was associated with blood lipid levels in 262 Utah children 9 and 10 years of age. An ancillary objective was to determine the extent to which demographic, physiological, and lifestyle factors confounded the fitness–cholesterol relation.

Methods

Subjects

A total of 262 children (162 boys and 100 girls) volunteered for participation in the study. Subjects were recruited by newspaper advertisements and word of mouth. Ninety-five percent of the subjects

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