Serum Cholesterol and Triglyceride Levels in 3,446 Children from a Biracial Community

The Bogalusa Heart Study

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SUMMARY  Serum lipid profiles of 3,446 (91% of population) children, ages 5-14 years, were determined in a biracial community (Bogalusa, Louisiana) as part of a program investigating the early natural history of atherosclerosis. Black children had significantly higher mean levels of serum cholesterol than white children (170 mg/dl vs 162 mg/dl, \( P < 0.0001 \)). On the other hand, significantly lower levels of triglycerides were found in blacks than in whites (61 mg/dl vs 73 mg/dl, \( P < 0.0001 \)). Girls had higher levels of triglycerides than boys in both races (blacks, 64 mg/dl vs 59 mg/dl, \( P < 0.001 \); whites, 77 mg/dl vs 69 mg/dl, \( P < 0.001 \)). The racial differences in serum cholesterol and triglyceride levels were even more apparent at the 95th percentile. The serum cholesterol level remained relatively constant in all children until ages 11 and 12 years, after which a slight reduction occurred. This reduction was more pronounced in boys than in girls. In contrast, a significant increase in the level of triglycerides with age was observed in all children except black girls, the increasing slope being most pronounced in white girls.

ATHEROSCLEROSIS PROBABLY begins during early childhood although the clinical sequelae do not appear until adulthood.1-4 Studies of arterial pathology have shown that fatty streaks are present in the aortas of children as young as three years of age,4 and that by age 20, raised lesions significant to the development of clinical disease have already begun to appear in coronary arteries.1-4 If these early lesions predispose children to coronary artery disease (CAD) during their adult years, and if there is a relationship between CAD risk factors (obesity, hypertension, and hyperlipidemia) and the progression of these lesions, then knowledge of risk factors in children is essential for the primary prevention of this disease.

Blood cholesterol has long been recognized as a major independent risk factor for CAD in adults.6-12 More recently, the level of blood triglycerides has been incriminated as a CAD risk factor independent of cholesterol12, 13 although the evidence for independence is not conclusive.10 Earlier studies on limited numbers of children have shown that the mean serum cholesterol levels for children 3 to 4 years of age already approach levels found in young adults.14, 15 The marked individual variability observed in these studies suggested a need for an epidemiologic survey of a larger defined population to detect subtle differences in serum cholesterol and triglycerides which might relate to race, sex, and early age.

In order to obtain information on the distributions, interrelationships, and course over time of CAD risk factors in a community of children, the Bogalusa Heart Study was initiated in 1972 in Bogalusa, Louisiana, as the major program of a Specialized Center of Research-Arteriosclerosis (SCOR-A). During the first phase of the study, the pediatric population of Bogalusa was screened. Extensive data were collected on serum cholesterol, triglycerides, lipoproteins, hemoglobin, blood pressure, selected anthropometric measurements, nutrition, and the parents' socioeconomic status; in addition, each child was given a complete physical examination by a physician. This paper reports the serum cholesterol and triglyceride data.

Materials and Methods

Population Sample

During the 1973-1974 school year, 3,524 children (37% blacks, 63% whites) ranging in age from 5-14 years, residing in Ward 4 (Bogalusa) of Washington Parish, Louisiana, were screened. This population represents 93% of the 3,786 children eligible. Ninety-seven percent of all black children and 91% of all white children were examined. Appropriate permission was obtained from a parent or guardian of each child. The eligible children were derived from a total population roster maintained by the Bogalusa school system. During the summer of 1974, a further evaluation was made of the nonexamined population. Based upon school records, the Bogalusa City Directory, and home visits, we were able to confirm that 262 Ward 4 children ages 5-14 years were eligible but were not examined in our study.

In order to take into consideration the possible influences of seasons upon the risk factors, examinations at the 14 Bogalusa schools (all but one racially integrated) were scheduled so that children of both races, both sexes and all ages were examined throughout the school year. Daily temperatures were recorded to evaluate potential seasonal effects.

Venipuncture was limited to two attempts; no blood samples were obtained from 78 children (2.2%). Each child was asked to fast for 12-14 hours before venipuncture; the duration since last food intake was determined by interview on the morning of the examination. Of the 3,446 samples, only 263 (7.6%) children reported as nonfasting. The 341 children with no blood samples or nonfasting blood samples consist of 9.5% of the white children and 10.0% of the black children.
Collection of Blood Specimens

The children were seated and venous blood was collected in vacutainer tubes. The blood was allowed to clot at room temperature for approximately 1½ hours. The clotted blood was centrifuged; the serum was extracted and placed into tubes containing the antibacterial agent Thimerosal (Aldrich Chemical Co., Milwaukee, Wis.), which were packaged with cold packs and sent by bus on the same day to New Orleans where they were immediately refrigerated at 4°C. The sera were extracted for analysis on the next day.

Serum Cholesterol and Triglyceride Determinations

All samples were analyzed in the SCOR-A Core Laboratory in New Orleans, which has been designated as “standardized” by the Center for Disease Control (CDC), Atlanta, Georgia, and currently is in the surveillance phase of the quality control program. Total serum cholesterol and triglycerides were analyzed simultaneously in a Technicon Auto-Analyzer II (Technicon Instrument Corp., Tarrytown, N.Y.) according to the protocol developed by the Lipid Research Clinics in collaboration with the CDC. Standardization and surveillance of lipid determinations requires that quality control sera are accurate to within 5% of the target value for serum cholesterol and within 9 mg/dl for serum triglyceride values between 0 and 249 mg/dl. An isopropanol extract of the serum was used for analyses. A serum calibrator, provided by the CDC, was used during every analytical run to convert the cholesterol values obtained by the Auto-Analyzer II to the standard reference method of Abell-Kendall. The CDC also provided cholesterol and triglyceride (triolein) standards.

Every day of screening, additional aliquots of blood were collected in random order on approximately 12% of the children (also selected randomly) for assessment of measurement errors. To ensure blind duplicate analyses, new names and new identification numbers were placed on the additional blood samples. Based on 431 duplicate samples, the standard deviations of the measurement errors for serum cholesterol and triglycerides were 9.14 mg/dl and 9.66 mg/dl, respectively; the coefficients of variation of the measurement errors were 5.5% and 13.3%. These values include not only the error in laboratory analyses of two independent samples but also that associated with the collection and processing of samples from the time of drawing until reporting of the values. A detailed analysis of the blind duplicate samples, the methodology for assessing measurement error, and the rationale for incorporating the laboratory controls in an epidemiologic survey will be published elsewhere.

Results

The effect of season on blood lipids did not appear to be significant in Bogalusa. The correlation of temperature with serum cholesterol was 0.05 and with serum triglycerides, 0.02. This lack of relationship is probably due to the mild temperature fluctuations observed in the southern United States. For the 1973–1974 school year, the mean temperature varied from a high of 77.8°F In September to a low of 50.2°F in December.

In order to determine the effect of a 12- to 14-hour fast on lipid levels, a comparison was made using Student’s t-test of blood samples from the 3,183 reported fasting children and the 262 nonfasting children. The distributions of cholesterol and triglyceride levels were skewed. However, the large samples involved made it unnecessary to transform the data for analysis. (The data were analyzed in both the log transformed and nontransformed states. The results of hypothesis tests were equivalent.) Figure 1 illustrates that there is no statistically significant difference between mean serum cholesterol levels in fasting (165.3 mg/dl) and nonfasting (162.7 mg/dl) children, whereas the mean level of serum triglycerides is significantly lower in fasting children (68.7 mg/dl for fasting versus 87.7 mg/dl, P = 0.0001). Therefore, in all subsequent analyses, cholesterol values for fasting and nonfasting subjects are combined, but triglyceride values are presented for only fasting subjects.

Total Serum Cholesterol

The racial distributions of total serum cholesterol in the children are shown in figure 2. Statistically significant differences were observed between whites and blacks, the former tending to be lower (mean levels of 162 mg/dl vs 170 mg/dl, P < 0.0001; Student’s t-test). For both races, serum cholesterol values appear to be normally distributed although the median values are slightly lower than the means (median values of 160 mg/dl in whites and 168 mg/dl in blacks), indicating the distributions are shifted very slightly toward higher values. In addition, there is a slight increase in the number of black children with cholesterol values in the interval between 226 and 235 mg/dl. The lowest value for serum cholesterol was 77 mg/dl while the maximum value was 346 mg/dl. As seen in table 1, the

![Figure 1. Distributions of total serum cholesterol and triglycerides in fasting and nonfasting children, ages 5–14 years, in the Bogalusa Heart Study.](http://circ.ahajournals.org/DownloadedFrom/10.1161/01.CIR.69.3.303_Fig1.png)
serum cholesterol concentrations were not significantly different between the races at every age interval but the mean concentration over the ten-year span was higher for blacks than whites. No consistent differences were observed in cholesterol levels between boys and girls in either racial group.

### Table 1. Mean, Standard Deviation and Range of Total Serum Cholesterol Levels in Bogalusa Children by Age, Race, and Sex

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Boys</th>
<th>Girls</th>
<th>Black children</th>
<th>Boys</th>
<th>Girls</th>
<th>White children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean ± sd</td>
<td>(range) mg/dl</td>
<td>N</td>
<td>Mean ± sd</td>
<td>(range) mg/dl</td>
</tr>
<tr>
<td>5</td>
<td>42</td>
<td>169.5 ± 26.8</td>
<td>(115-237)</td>
<td>37</td>
<td>167.7 ± 22.1</td>
<td>(128-226)</td>
</tr>
<tr>
<td>6</td>
<td>53</td>
<td>169.8 ± 37.5</td>
<td>(112-286)</td>
<td>56</td>
<td>178.9 ± 31.8</td>
<td>(120-278)</td>
</tr>
<tr>
<td>7</td>
<td>54</td>
<td>170.3 ± 36.9</td>
<td>(104-276)</td>
<td>60</td>
<td>170.4 ± 32.4</td>
<td>(102-248)</td>
</tr>
<tr>
<td>8</td>
<td>64</td>
<td>164.7 ± 29.3</td>
<td>(82-231)</td>
<td>52</td>
<td>178.7 ± 33.2*</td>
<td>(114-267)</td>
</tr>
<tr>
<td>9</td>
<td>82</td>
<td>177.2 ± 36.9</td>
<td>(108-293)</td>
<td>59</td>
<td>172.5 ± 29.7</td>
<td>(106-248)</td>
</tr>
<tr>
<td>10</td>
<td>74</td>
<td>169.0 ± 28.6</td>
<td>(105-259)</td>
<td>60</td>
<td>171.9 ± 32.1</td>
<td>(97-254)</td>
</tr>
<tr>
<td>11</td>
<td>74</td>
<td>171.0 ± 29.5</td>
<td>(77-254)</td>
<td>69</td>
<td>174.4 ± 32.9</td>
<td>(87-307)</td>
</tr>
<tr>
<td>12</td>
<td>85</td>
<td>173.3 ± 31.2*</td>
<td>(77-274)</td>
<td>77</td>
<td>163.7 ± 24.0</td>
<td>(113-241)</td>
</tr>
<tr>
<td>13</td>
<td>74</td>
<td>160.3 ± 25.2</td>
<td>(116-251)</td>
<td>72</td>
<td>167.7 ± 25.2</td>
<td>(93-225)</td>
</tr>
<tr>
<td>14</td>
<td>67</td>
<td>164.9 ± 25.8*</td>
<td>(120-236)</td>
<td>63</td>
<td>166.6 ± 28.5*</td>
<td>(122-274)</td>
</tr>
<tr>
<td>Total</td>
<td>669</td>
<td>169.2 ± 31.2*</td>
<td>(77-293)</td>
<td>605</td>
<td>170.9 ± 29.6*</td>
<td>(87-307)</td>
</tr>
</tbody>
</table>

*Sex differences significant at P < 0.05 (F test).
1, 11, 111 Race differences significant at P < 0.05, P < 0.01, or P < 0.001 (F test), respectively.

The linear regression of cholesterol with age is shown in table 2 for 5- through 10-year-olds and for 11- through 14-year-olds. The two age groups were selected to assess the linear tendency of cholesterol levels during both the preadolescent and the early adolescent years. No significant change with age is observed in the 5- through 10-year-old group. A negative slope is seen in children ages 11 through 14 years, but the correlation is significantly different from zero only in white boys; however, none of the correlation coefficients are large.

The median and selected percentile levels for serum cholesterol by age, race, and sex are shown in figure 3. Cholesterol levels remain relatively constant in all children until ages 11 and 12, after which a slight reduction occurs, more pronounced in boys than in girls. At the median (50th percentile), blacks exceed whites at every age interval. This same difference in cholesterol levels between the races is even greater at the 95th percentile except for 12- and 13-year-old girls. Ninety-five percent of all black children have serum cholesterol levels below 226 mg/dl whereas 95% of all white children are below 210 mg/dl. The 5th percentile levels for blacks and whites are 126 mg/dl and 121 mg/dl, respectively.

**Serum Triglycerides**

The distributions of serum triglycerides (fig. 2) indicate that white children tend to have higher triglyceride levels than black children (means of 73 mg/dl vs 61 mg/dl, P < 0.0001; Student's t-test) in direct contrast to the observations of cholesterol noted above. The triglyceride levels, however, are definitely skewed toward high values in the distributions of both blacks and whites. As a reflection of the skewness, the median value is less than the mean by 8 mg/dl in white children, and by 6 mg/dl in black children. The
range for triglyceride values in all fasting children was between 8 mg/dl and 506 mg/dl.

Because the distributions are skewed, statistical analyses were performed on untransformed and log 10 transformed data in line with other investigators. The results from the two sets of analyses were essentially identical. The central limit theorem states that for a random sample from a distribution with finite variance, the distribution of a sample mean approaches normality as the sample size increases. Hence, only the analyses of untransformed data are presented.

Serum triglyceride levels in children tend to increase with age in all race-sex groups (table 2) although this increase is very slight in blacks. All children ages 5–14 years were combined since the onset of adolescence appeared to have a minimal effect on triglyceride levels. Although the slopes for white children are significantly different from zero, the proportion of variance of serum triglycerides explained by linear regression on age is only between 1.2% and 3.2% ($r^2$).

In a comparison of four race-sex groups, white children have significantly higher levels of serum triglycerides than black children (table 3), and girls have higher levels than boys in both racial groups although these differences are not maintained throughout each age interval.

Three sets of percentile levels for serum triglycerides are shown in figure 4. The lack of uniformity at the 95th percen-
Table 3. Mean, Standard Deviation and Range of Serum Triglyceride Levels in Fasting Bogalusa Children by Age, Race, and Sex

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Boys</th>
<th>Girls</th>
<th>White children</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± sd (range) mg/dl</td>
<td>Mean ± sd (range) mg/dl</td>
<td>Mean ± sd (range) mg/dl</td>
<td>Mean ± sd (range) mg/dl</td>
</tr>
<tr>
<td>5</td>
<td>55.6 ± 20.2 (34 – 118)</td>
<td>67.1 ± 29.4 (29 – 176)</td>
<td>69.4 ± 27.1 (30 – 150)</td>
<td>84.8 ± 23.7 (31 – 138)</td>
</tr>
<tr>
<td>6</td>
<td>57.0 ± 21.3 (21 – 109)</td>
<td>61.1 ± 21.7 (30 – 145)</td>
<td>64.1 ± 32.0 (28 – 243)</td>
<td>66.5 ± 30.4 (26 – 175)</td>
</tr>
<tr>
<td>7</td>
<td>52.8 ± 19.1 (19 – 108)</td>
<td>59.1 ± 21.9 (25 – 117)</td>
<td>62.5 ± 25.1 (8 – 135)</td>
<td>74.2 ± 33.5**,**††</td>
</tr>
<tr>
<td>8</td>
<td>56.9 ± 26.4 (22 – 165)</td>
<td>63.4 ± 20.3 (32 – 112)</td>
<td>62.8 ± 31.1 (28 – 228)</td>
<td>69.2 ± 31.1 (19 – 183)</td>
</tr>
<tr>
<td>9</td>
<td>61.5 ± 31.2 (24 – 172)</td>
<td>62.2 ± 24.8 (32 – 160)</td>
<td>66.1 ± 31.3 (26 – 236)</td>
<td>73.4 ± 29.9††</td>
</tr>
<tr>
<td>10</td>
<td>53.3 ± 20.1 (24 – 119)</td>
<td>66.5 ± 37.9* (22 – 305)</td>
<td>69.2 ± 34.2†‡</td>
<td>80.8 ± 41.9*‡‡</td>
</tr>
<tr>
<td>11</td>
<td>64.3 ± 24.3 (22 – 149)</td>
<td>67.2 ± 24.5 (24 – 146)</td>
<td>75.3 ± 46.9 (24 – 315)</td>
<td>87.1 ± 60.8*††</td>
</tr>
<tr>
<td>12</td>
<td>60.3 ± 22.3 (24 – 162)</td>
<td>62.4 ± 17.1 (28 – 114)</td>
<td>68.2 ± 33.9 (20 – 200)</td>
<td>84.8 ± 34.7***,**††</td>
</tr>
<tr>
<td>13</td>
<td>60.5 ± 28.1 (27 – 196)</td>
<td>63.2 ± 23.4 (33 – 154)</td>
<td>72.7 ± 29.3†‡</td>
<td>82.3 ± 32.4*†††</td>
</tr>
<tr>
<td>14</td>
<td>65.5 ± 23.6 (33 – 154)</td>
<td>63.2 ± 19.5 (29 – 120)</td>
<td>78.2 ± 32.4†‡</td>
<td>83.3 ± 30.6†††</td>
</tr>
<tr>
<td>Total</td>
<td>59.2 ± 24.8 (19 – 196)</td>
<td>63.7 ± 24.3* (22 – 305)</td>
<td>68.9 ± 33.5†††</td>
<td>77.3 ± 37.6***,**†††</td>
</tr>
</tbody>
</table>

* **Sex differences significant at P < 0.05, F < 0.01, or F < 0.001 (F test).
† † † † Race differences significant at P < 0.05, F < 0.01, or F < 0.001 (F test).

The interrelationship of serum cholesterol and triglycerides in various age-race-sex groups is shown in Table 4. A percentage of black children are between 32 mg/dl (5th percentile) and 105 mg/dl (95th percentile).

Interrelationship between Serum Cholesterol and Serum Triglycerides

The interrelationship of serum cholesterol and triglycerides in various age-race-sex groups is shown in Table 4. A

![Figure 4. Percentiles for serum triglycerides (fasting) by race and sex in children, ages 5-14 years.](http://circ.ahajournals.org/)

**percentile** is due to the high variability at the extremes. The levels for all groups at the 95th percentile vary from a low of 91 mg/dl in 7-year-old black boys to a high of 181 mg/dl in 11-year-old white girls. Discounting any sex differences or increases with age, the triglyceride values of 90% of the white children are between 36 mg/dl (5th percentile) and 136 mg/dl (95th percentile), whereas the values for the same
positive correlation between levels of the two blood lipids (only fasting children) is observed in whites for each two-year age group. In black children, the correlation coefficients among the five age groups are lower than in white children with the exception of 7- to 8-year-old girls. Using the method outlined in Snedecor and Cochran, a statistical test was made to determine if both racial sets of correlation coefficients are from the same underlying population. The correlation coefficient of total serum cholesterol with serum triglyceride in children 5 through 14 years old is significantly higher in white children than the coefficient in black children for both boys (whites, \( r = 0.27 \), blacks, \( r = 0.14; P < 0.01 \)) and girls (whites, \( r = 0.24; \) blacks, \( r = 0.11; P < 0.02 \)).

### Discussion

The levels of both serum cholesterol and serum triglycerides are highly variable within a population and require large numbers of people before subtle differences become statistically significant. Obviously, care must be taken in the interpretation of these results since in a large sample size, group differences which are statistically significant may or may not be important from a biological standpoint. Our mean levels of cholesterol agree relatively well (within 10 mg/dl) with values found by numerous investigators in the United States, although recently reported Muscatine study is a notable exception with a mean serum cholesterol level in white children 20 mg/dl higher than in our comparable population (Bogalusa, 162 mg/dl; Muscatine, 182 mg/dl). Our values are lower by more than 30 mg/dl than levels reported in Swedish or Australian children, but, many of these studies are not directly comparable because of different analytical methods used for determining serum cholesterol.

Analytical variation is also a major consideration when comparing triglyceride levels in different study populations. Although studies of blood triglycerides in children are limited, our mean levels in Bogalusa are in close agreement (within 10 mg/dl) with other investigators analyzing blood from fasting children. A major exception was reported by Hodges et al. for nonfasting girls between 14 and 17 years old in Iowa who had a mean value of 45 mg/dl, almost half the level of the oldest group of fasting white girls in Bogalusa.

Because of technical limitations, it is important to appreciate potential errors which can occur in the field as well as in the laboratory. Detailed analyses of our data for sources of measurement error (unpublished observations) show that the 95% confidence interval for a single analysis of serum cholesterol and triglycerides is approximately \( \pm 18 \) mg/dl. Given this range of potential error, it is important to note how difficult it is to derive an accurate lipid profile for a given individual from a single blood sample, even in a rigidly controlled research laboratory.

The age-related changes in blood lipid levels are important although they cannot be clearly explained at this time. The progressive increase in triglycerides, most obvious in white girls, suggests a relative increase in body fat possibly resulting from overeating or underexercise. In contrast, however, there is a tendency for a decrease in cholesterol around puberty, more obvious in boys, which likely reflects marked hormonal influences. A similar decline in serum cholesterol at this stage of sexual maturation in boys has been observed in other cross-sectional studies and in both boys and girls in a longitudinal study. From our knowledge of serum cholesterol and triglyceride levels in adults, we can assume that the trend of triglyceride concentrations to increase with age should continue, whereas the slight negative trend in serum cholesterol levels in 11- through 14-year-olds should be reversed and start to increase during late adolescence and continue upward through adulthood.

The differences between the races in blood cholesterol or triglycerides were not noted in New York or in Evans County, Georgia; however, neither study had a sample size as large as the Bogalusa Heart Study.

The differences between races in Bogalusa are likely due to genetic influences, although environmental factors such as diet and socioeconomic status may also have a contributing effect. Education and occupation data were collected on the head of the child’s household by a mailed questionnaire. Based upon our initial analyses, there was little association between the household head’s social status and the lipid levels of the children. A further evaluation of these data is in progress. The differences noted in the correlation of serum cholesterol with serum triglycerides between the races does suggest that there are relative differences in the levels of the lipoprotein macromolecules (table 4). We have reported data from a neighboring community showing that black children tend to have higher levels of \( \alpha \)-lipoproteins than whites. Given the recent observations reviewed by Miller et al. that the cholesterol in high density lipoprotein molecules (\( \alpha \)-lioprotein cholesterol) and triglycerides in very low density lipoprotein molecules are negatively correlated, the higher levels of \( \alpha \)-lipoprotein and lower levels of serum triglycerides in blacks could tend to minimize the correlation between cholesterol and triglycerides while the lipoprotein levels in whites result in a higher correlation of the same two lipids. Recent observations by Tyroler in black adults living in Evans Country, Georgia have also indicated that more cholesterol is found in \( \alpha \)-lipoproteins than in a comparable group of whites.

Since cholesterol and possibly triglyceride levels in adults are related to a risk of CAD that increases at every elevated level, considerable debate has centered around what should be considered desirable levels in children. Drash feels that 200 mg/dl of blood cholesterol is a reasonable upper limit in

### Table 4. Pearson Product Moment Correlation Coefficient of Total Serum Cholesterol with Serum Triglycerides by Two-Year Age Groups, Race, and Sex, in Fasting Bogalusa Children

<table>
<thead>
<tr>
<th>Age (in years)</th>
<th>White Boys</th>
<th>Black Boys</th>
<th>White Girls</th>
<th>Black Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 – 6</td>
<td>0.408</td>
<td>0.166</td>
<td>0.241</td>
<td>-0.025</td>
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<tr>
<td>(162)*</td>
<td>(74)*</td>
<td>(165)*</td>
<td>(81)*</td>
<td></td>
</tr>
<tr>
<td>7 – 8</td>
<td>0.204</td>
<td>0.152</td>
<td>0.242</td>
<td>0.184</td>
</tr>
<tr>
<td>(222)</td>
<td>(151)</td>
<td>(203)</td>
<td>(115)</td>
<td></td>
</tr>
<tr>
<td>9 – 10</td>
<td>0.292</td>
<td>0.141</td>
<td>0.229</td>
<td>0.086</td>
</tr>
<tr>
<td>(248)</td>
<td>(151)</td>
<td>(233)</td>
<td>(138)</td>
<td></td>
</tr>
<tr>
<td>11 – 12</td>
<td>0.251</td>
<td>0.247</td>
<td>0.350</td>
<td>0.030</td>
</tr>
<tr>
<td>(203)</td>
<td>(123)</td>
<td>(188)</td>
<td>(129)</td>
<td></td>
</tr>
</tbody>
</table>

*Number of children in population.
children\(^5\) whereas Fredrickson et al. have suggested upper normal limits of 230 mg/dl.\(^{9,10}\) Figure 5 shows that in Bogalusa 9% of the white children and 13% of the black children have cholesterol values higher than 200 mg/dl and that 1.5% of the whites and 4.1% of the blacks have values higher than 230 mg/dl. Kannel and Dawber have suggested that blood cholesterol be monitored on a periodic basis in all children whose cholesterol values exceed 160 mg/dl.\(^3\) As seen in figure 5, this level would include 50% of our white children and 61% of our black children.

For blood triglycerides in children from birth to 19 years of age, Fredrickson et al.\(^{9,10}\) recommend an upper normal limit of 140 mg/dl, a value exceeded in Bogalusa by only 4.3% of the white children and 1.4% of the black children. Only five white children (0.25%) and one black child (0.09%) had triglyceride levels greater than 140 mg/dl and cholesterol levels exceeding 230 mg/dl.

The reported lipid data are to be considered baseline levels of both serum triglycerides and cholesterol in children ages 5 through 14 years. There is a difference between "normal" and "optimal" lipid levels,\(^9,10\) and these data are presented only as observations within a single community and as a basis for comparing values obtained on other children. Our findings from 91% of a defined geographic community allow the detection of subtle differences in levels of blood lipids related to age, race, and sex. Although biases due to selective participation may be present, the effect of not including 9% of the population is probably minimal. All of our data were collected in a rigidly standardized manner with great emphasis on detecting possible errors of measurement. As a result, these data should provide normative guidelines to physicians, nutritionists, and other investigators for evaluating lipid levels in a pediatric population.

At this time, it is premature to speculate on the significance of specific levels in children but in view of the high incidence of coronary artery disease in adults and the premise that an elevated level of the blood lipids means an increased risk, median or mean levels may serve as useful guidelines for further evaluation and for observing children over time.

**References**

SUMMARY Serum lipoprotein profiles in 3182 children, ages 5–14 years, were studied in a biracial community as part of the Bogalusa Heart Study to describe the early natural history of atherosclerosis. White and black children showed similar mean levels of β-lipoproteins. Pre-β-lipoprotein levels, however, were significantly higher in white children, while significantly higher levels of α-lipoprotein were found in black children. Girls had generally higher levels of β- and pre-β-lipoprotein and lower levels of α-lipoprotein than boys, although the differences were not significant at each age group. With age there was little change in α-lipoprotein levels, a significant increase in pre-β-lipoprotein levels and a slight but significant decrease between 11 and 14 years in β-lipoprotein levels. The correlation of α-lipoprotein was negative with β-lipoprotein and, to a greater extent, with pre-β-lipoprotein. The above inverse relationships were significantly greater in white children than in black children, suggesting differences in lipoprotein profiles in the two groups. Lipoprotein values from a total community study are now available for comparison with the currently recommended upper normal limits for lipoproteins. Since only a very small percentage of children could be considered as hyperlipoproteinemic by those specific levels in this community, we suggest that distributions and percentiles be used to evaluate children for hyperlipoproteinemia.

ELEVATED LEVELS of certain serum lipoprotein fractions have been clearly recognized as one of the important risk factors for coronary artery disease. It is also known that coronary atherosclerosis begins early in life;1–3 consequently, attention has recently been focused on risk factors in children.4–6 There has been a surge of interest in identifying problems associated with hyperlipoproteinemia in children and in comparing lipoprotein levels of parents and their children.7–11 Serum lipids in free-living children have been studied mostly in terms of cholesterol and triglycerides.12–15 The introduction of simple methods to determine lipoproteins for clinical purposes now allows studies to be performed on large numbers of children. Recently serum lipoprotein profiles have been reported in only a limited number of free-living children.16–18 It was apparent from these studies that the extreme individual variability in lipoprotein levels makes larger samples necessary to detect subtle differences possibly related to race, sex, and early age.

The Bogalusa Heart Study was initiated as part of a Specialized Center of Research-Arteriosclerosis (SCOR-A) in a biracial community (Bogalusa, Louisiana) to study the early natural history of atherosclerosis in a large pediatric population. The serum cholesterol and triglyceride levels in 5 to 14-year-old children of this community have been reported elsewhere.19 The following study describes the serum lipoprotein profile in these children.

Materials and Methods

Population Sample

We examined 3524 children, representing 93% of all children ages 5–14, residing in Ward 4 (Bogalusa) of Washington Parish, Louisiana, for coronary artery disease risk factors. Of the 1840 boys and 1684 girls examined, 37% were black and 63% were white. Children of all ages were examined throughout the school year to account for seasonal influences on serum lipoprotein levels. Children were instructed to fast for 12–14 hours prior to the exam. Accord-
Serum cholesterol and triglyceride levels in 3,446 children from a biracial community: the Bogalusa Heart Study.
R R Frerichs, S R Srinivasan, L S Webber and G R Berenson

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