Plasma Cholesterol Concentrations in Twin Children: Estimates of Genetic and Environmental Influences, Walter Mastropolo, Adam Matheny, Jr., and Calvin A. Lang (1 Floyd Memorial Hospital, 1850 State St., New Albany, IN 47150; 2 Department of Pediatrics Louisville Twin Study and 3 Department of Biochemistry and Molecular Biology, University of Louisville School of Medicine, Louisville, KY 40292; * author for correspondence: fax 812-949-5810, e-mail wmast@otherside.com)

Because increased plasma cholesterol is a risk factor for cardiovascular disease, an important question concerns the degree to which this risk is attributable to genetic or environmental influences. Previous studies, largely consisting of older children and adult twin pairs, have indicated environmental contribution to the variation of cholesterol concentration among individuals of 7–68% in the populations evaluated (1–5). We performed a study to determine the extent of genetic and environmental influences on plasma cholesterol in pairs of twin children ages 2–9 years. We are not aware of similar studies in this age group. A complete age profile addressing the question of environmental vs genetic influence on serum cholesterol is important because the finding of a substantial environmental influence would encourage vigilance for controlling cardiovascular disease risk factors beginning at an early age.

The subjects were 57 pairs of healthy twin children between the ages of 23 and 108 months (mean, 54 months), reared together and participating in the Louisville Twin Study, a longitudinal study of twins from infancy to adulthood. The twins were from families recruited to represent the entire socioeconomic range of families with children in the Louisville, KY metropolitan area. Occupations of heads of household, converted to Duncan’s scores (6), indicated that ~30% of families were in the lowest two deciles. The completed education of the parents ranged from 8th grade to professional degrees. All recruitment and longitudinal procedures, as well as consent forms, were reviewed and approved yearly by the Human Subjects Committee of the University of Louisville. Written consent for the venipuncture procedure performed on the twins in the present study was obtained from their parents. The sample studied consisted of 42 pairs of identical [monozygotic (MZ)] twins (23 female pairs, 19 male pairs) and 15 same-sex pairs of fraternal [dizygotic (DZ)] twins (9 female pairs, 6 male pairs).

EDTA-plasma samples were obtained by venipuncture performed on each twin of the pair during the same visit to the research center. The specimens were analyzed for cholesterol on an Boehringer Mannheim Hitachi 704 analyzer. Statistical analysis applied to the concentrations of plasma cholesterol consisted of the Student t-test (comparison of females with males), correlations (association of cholesterol concentration with age and physical stature), and intraclass correlations (adjusted for age, sex, and physical stature) for the intrapair similarities of cholesterol concentration within MZ and DZ pairs. An estimate for heritability, \( h^2 \), which is the proportion of a characteristic attributed to genetic variation, of cholesterol was obtained by Falconer’s method (7) for estimating broad-sense heritability: \( h^2 = 2 (r_{MZ} - r_{DZ}) \), where \( r \) is the intraclass correlation coefficient.

There were no significant differences between male and female plasma cholesterol concentrations (mean ± SD): 3.96 ± 0.62 mmol/L (153 ± 24 mg/dL) for females; 3.82 ± 0.54 mmol/L (148 ± 21 mg/dL) for males. In addition, there were no significant correlations between plasma cholesterol and age (\( r = 0.16 \)) or physical stature (\( r = 0.01 \) for weight; \( r = 0.12 \) for height).

The adjusted intraclass correlations for plasma cholesterol were 0.80 (95% confidence interval, 0.72–0.87; \( n = 42 \)) for the MZ pairs and 0.68 (95% confidence interval, 0.40–0.83; \( n = 15 \)) for the DZ pairs. Although the correlation for the MZ pairs was higher than that for the DZ pairs, the difference between the correlations was not significant. Application of Falconer’s method (7) for broad-sense heritability produced a heritability of 0.24. In other words, this indicates that of the variation of plasma cholesterol concentration within this sample of young children, 24% is attributable to genetic influences and 76% is attributable to environmental influences. Our conclusion from these analyses is that among young children, the plasma cholesterol concentration is influenced predominately by environmental conditions. Other similar studies in older individuals (1–5) found a broad range of heritability estimates for the variation of plasma cholesterol. Studies based on autopsy examinations of children as young as 15 years indicated the formation on atherosclerotic lesions in this population. The extent of these lesions was related to known cardiovascular risk factors, including lipids (8). These studies and our finding of the importance of environment in determining plasma cholesterol indicate that the control of risk factors associated with cardiovascular disease at an early age should be evaluated by additional investigations.

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References