Serum Lipids in Adult Twins

The possible role of lipid metabolism in the etiology of atherosclerosis has focused attention upon environmental, mainly nutritional, factors which may affect lipid levels in serum (*1*). This report is concerned with the influence of heredity upon variations in lipid levels in serum (*2, 3*). Since genetic differences are a known factor in twins, twins have been used for the study of the problem.

Caucasian twin pairs ranging in age from 18 to 55 years, from a low- to upper-middle income population in New York City, have been studied. Their health status has been established by thorough health histories and by medical examinations (*4*). Determination of total serum cholesterol, cholesterol esters, and phospholipids were obtained for 82 of these twin pairs who were found to be in good general health. The total cholesterol and free cholesterol in serum were determined by the Sperry-Schoenheimer method, and phospholipid was determined by means of Sperry's modification of the Fiske-SubbaRow method.

The diagnosis of twin zygosity was established by serological and morphological comparisons (*4*). Each pair was classified according to whether the two members had been living together or living apart prior to and at the time of study. Statistical comparisons were based upon mean variances, the mean *intrapair* variance being $\Sigma x^2/2n$, where x is the difference between the two members of a twin pair for the measured lipid levels in milligrams per 100 ml, and n is equal to the number of twin pairs. The mean *interpair* variances were calculated from the averages of the values for the two members of each twin pair. The mean variances obtained from these pair averages were multiplied by two to make them comparable to the intrapair variances, since the latter were based upon individuals, and the interpair variances upon means of pairs of individuals. Variance or F ratios have been calculated, and the F distribution has been used to obtain the probability levels of these ratios.

The intrapair variances of monozygotic twins did not differ significantly from those of dizygotic twins of the same sex. In every instance, however, the dizygotic variance was the larger. In both monozygotic and dizygotic twins, the variances of pairs living apart were larger than those for pairs living together. In the female monozygotic twins, the "apart" mean variances of pairs living apart were larger for total cholesterol and phospholipid at the 5-percent level of significance. It is the consistency in the direction of the ratios (monozygotic to dizygotic and "together" to "apart") rather than their actual magnitude which implies that both genetic and environmental factors influence (possibly in an accumulative way) variations in "normal" serum lipid levels.

Table 1. Mean intrapair and interpair differences in total cholesterol in serum of monozygotic and dizygotic twins living together and living apart (*8*).

Sex	Residence	Comparison	D.F.	Variance	F	P
		Monozygotic				
Male	Together	Intrapair	14	279.536	9.95	< .001
		Interpair	18	2780.492		
Male	Apart	Intrapair	5	340.100	8.18	< .025
		Interpair	18	2780.492		
Female	Together	Intrapair	14	205.821	9.52	< .001
		Interpair	23	1960.290		
Female	Apart	Intrapair	10	602.050	3.26	> .025
		Interpair	23	1960.290		
		Dizygotic				
Male	Together	Intrapair	6	694.250	2.19	> .10
		Interpair	6	1519.144		
Female	Together	Intrapair	9	365.611	4.10	> .01
		Interpair	21	1498.178		
Female	Apart	Intrapair	13	868.615	1.73	< .25
		Interpair	21	1498.178		
Unlike Sex	Together	Intrapair	5	302.500	6.68	> .025
		Interpair	8	2022.000		
Unlike Sex	Apart	Intrapair	4	1090.625	1.85	> .25
		Interpair	8	2022.000		

In Table 1 the mean intrapair and interpair differences in total cholesterol content of the serum are compared. In monozygotic twins living together, genetic identity and the greatest environmental similarity seen in this study are contrasted with the statistical equivalent of unrelated people. At the other extreme are the dizygotic twins living apart; their ratios contrast the greatest genetic and environmental dissimilarity observed in this sample with the statistical equivalent of unrelated people. Whereas the first extreme provides the largest F ratios, 9.52 to 9.95, the latter shows the smallest F ratios, 1.73 to 1.85. Between these extremes there is a range of variation as genetic and environmental differences change in monozygotic twins living apart and dizygotic twins living together. A parallel analysis for cholesterol esters and phospholipids provides results comparable to those presented for total serum cholesterol (*5*).

The present analysis demonstrates that variation of lipid levels in serum results from both genetic and environmental influences (*6*). It further indicates the relative magnitude of these influences necessary to produce statistically measurable variations in lipid levels in serum of an adult population in essentially good health. Significant effects were obtained when the genetic and environmental differences of people who are unrelated were contrasted (i) with genetically identical people with environmental differences limited by a common family background and (ii) with people of the first degree of relationship sharing a common home environment. The latter observation is comparable to the findings of a study of families reported by Adlersberg, Schaefer, and Steinberg (*7*).

In conclusion, the present findings demonstrate the importance of both genetic and environmental factors in the regulation of lipid levels in serum. It may be assumed, therefore, that genetic factors will not be equally important in all environments and that the environmental tolerances of one population will not equal those of another population.

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References and Notes

1. A. Keys and P. D. White, *Cardiovascular Epidemiology* (Hoeber-Harper, New York, 1956).
2. Acknowledgment is given to the Presbyterian Hospital Blood Bank and the Department of Medicine of the Columbia-Presbyterian Medical Center and to Frances V. DeGeorge, C. I. Wang, L. E. Schaefer, and S. R. Drachman for assistance. The study was supported by the Commonwealth Fund of New York (R. H. Osborne) and by the U.S. Public Health Service, Division of Grants and Fellowships (D. Adlersberg).
3. A detailed report on the investigation of serum lipids in twins is in preparation.
4. R. H. Osborne, "Hereditary and environmental factors in body build: a study of 100 pairs of adult twins" (Dissertation Abstracts, University Microfilms, Ann Arbor, Mich., 1956).
5. A description of the results is in preparation.
6. A heritability ratio could be computed from our data to indicate the proportion of the total variances which can be accredited to heredity versus environment. Because of reservations concerning this ratio, this computation has not been done.
7. D. Adlersberg, L. E. Schaefer, A. G. Steinberg, *Circulation* 16, 487 (1957).
8. No comparison of male dizygotic twins living apart is possible, for only two pairs of male dizygotic twins living apart were obtained for study.

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