Sex-related differences in the concentrations of apolipoprotein E in human blood plasma and plasma lipoproteins

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Abstract Apolipoprotein E (apoE) and lipoprotein cholesterol and triglycerides were measured in blood serum of 272 persons randomly selected from a large industrial population in northern California. Serum apoE level increased linearly by 0.013 mg/dl with each 1 mg/dl increase in very low density lipoprotein (VLDL) triglycerides. This estimate was independent of sex and the use of sex hormones by women. Compositional studies of isolated apoVLDL in 156 hypertriglyceridemic men and 162 normotriglyceridemic persons of both sexes from the same population also indicated that the content of apoE was independent of VLDL level, sex, and hormone use. The estimate of the relationship between serum apoE and VLDL-triglycerides derived from these compositional studies was comparable to that derived by regression analysis. Regression analysis also indicated that only 10–20% of the apoE in the serum of the average person is in the VLDL fraction. Serum apoE levels were 1.4 mg/dl higher in women than in men with the same VLDL-triglyceride level and 1.8 mg/dl lower in women using contraceptive drugs than in nonusers of like age and VLDL-triglyceride level.—**Phillips, N. R., R. J. Havel, and J. P. Kane.** Sex-related differences in the concentrations of apolipoprotein E in human blood plasma and plasma lipoproteins. *J. Lipid Res.* 1983. **24:** 1525–1531.

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Apolipoprotein E (apoE) is found in all the major ultracentrifugal classes of plasma lipoproteins of mammals, but appears to reside predominantly in triglyceride-rich lipoproteins and a subclass of high density lipoproteins (HDL) that is larger and of lower density than the bulk of HDL (1–8). ApoE transfers readily between lipoprotein classes (4, 9–13) and its transfer from HDL to triglyceride-rich lipoproteins appears to have functional significance for the metabolism of remnants of chylomicrons and VLDL (14, 15).

In humans, serum apoE level covaries with serum triglyceride level (5, 6, 16), but the level is disproportionately higher in persons homozygous or heterozygous for an allele specifying the dysfunctional apoE (E-2) (6, 7, 17). In the present report we present an analysis of the cross-sectional relationship between serum apoE level and the lipoprotein cholesterol and triglyceride levels. Because ultracentrifugation partially dissociates apoE from lipoproteins (1–3, 5–7), we have used regression analysis to expand upon our earlier observation (6) that women have higher serum apoE levels than men, despite their lower serum triglyceride levels, and to evaluate the influences of use of contraceptive drugs and estrogen replacement therapy upon apoE levels in women. The mass of apoE in the average VLDL particle does not appear to be influenced by sex or use of contraceptive drugs or estrogens. However, a substantial fraction of serum apoE in the average person is associated with lipoproteins other than VLDL. The amount of this apoE, presumably associated predominantly with a subclass of HDL, is much higher in women than in men and is reduced with use of contraceptive steroid, but not by estrogen replacement therapy alone.

MATERIALS AND METHODS

Study subjects

The study subjects were drawn from employees of the Southern Pacific Railroad in the San Francisco Bay and Sacramento-Roseville areas of California who participated in a previously described (18) survey of hyperlipoproteinemia conducted between November, 1972 and August, 1976. Blood specimens were obtained from 3,678 (78%) of the men and 969 (75%) of the women randomly selected without replacement over the course of the survey. Eighty percent of men and 70% of women in this multiracial population were of European racial heritage. Thirty-six percent of white women were taking sex steroids.

Abbreviations: apoE, apolipoprotein E; VLDL, very low density lipoprotein(s); LDL, low density lipoprotein(s); HDL, high density lipoprotein(s); TMU, 1,1,3,3-tetramethylurea.

TABLE 1. Mean levels of cholesterol and triglyceride in whole serum and lipoprotein fractions of persons measured for serum apolipoprotein E

	Men		Women		
	Unselected N = 86	Triglycerides > 200 mg/dl N = 51	No Exogenous Sex Steroids N = 86	Contraceptive Drugs N = 31	Estrogen Alone N = 18
			mg/dl		
Mean cholesterol level					
Whole serum	208.8	256.8	209.0	191.0	231.5
VLDL fraction	18.1	80.6	11.6	10.6	16.7
LDL fraction	141.5	139.2	137.2	118.6	142.9
HDL fraction	49.2	37.0	60.2	61.8	71.9
Mean triglyceride level					
Whole serum	114.5	416.4	84.2	93.9	113.2
VLDL fraction	76.7	334.6	45.2	43.5	58.8
LDL fraction	26.4	60.7	26.1	33.3	35.6
HDL fraction	114.0	21.0	12.8	17.1	18.8

Total cholesterol and triglycerides were measured in all specimens and a portion of each person's serum was stored at −20°C. The cholesterol and triglyceride levels within the three major lipoprotein classes were measured in the fresh sera from a sex-specific random subsample of persons and in all other sera with a cholesterol level > 250 mg/dl or a triglyceride level > 150 mg/dl.

ApoE was measured in 272 stored sera in 1978. These sera came from white persons representing one of the following five groups: *1*) women, aged 20–64 years, not taking sex steroids; *2*) women, aged 20–39 years, taking contraceptive drugs; *3*) women, aged 45–64 years, taking estrogens without progestins; *4*) men, aged 20–64 years, unselected with respect to serum triglyceride level; and *5*) men, other than those represented in the unselected group, with serum triglyceride levels > 200 mg/dl. Fourteen percent of surveyed white men, but less than 4% of women, had triglyceride levels of this magnitude.

The samples for all groups but the last one were drawn from the subsample of persons randomly selected for quantification of lipoprotein-lipid levels. Excluded from all five groups were nonfasting persons and persons taking any of the following medications: lipid-lowering drugs, high blood pressure medications, diuretics, gout medications, thyroid, insulin, oral antidiabetic agents, and amphetamines. With the exception of the group of hypertriglyceridemic men, sample selection within groups was stratified by 5-year age group to yield a uniform distribution across the age range represented. **Table 1** gives the sample size and mean levels of cholesterol and triglycerides in the whole serum and lipoprotein fractions of each sample group. All but 2 of the 31 contraceptive drug users were using a combination formulation. Thirteen were taking mestranol in combination with norethindrone. The remaining 16 contraceptive drug users were taking one of five other estrogen-progestin combinations: mestranol with either norethynodrel or ethynodial diacetate and ethinyl estradiol with either ethynodiol diacetate, norethindrone acetate, or norgestrel. None was taking a low estrogen preparation (<0.05 mg). Of the 18 women receiving only estrogen, 12 were taking conjugated equine estrogens, one half in a daily dose of 0.625 mg and the other half 1.25 mg.

The apolipoprotein composition of VLDL was determined on 156 white men tested in the last half of the survey with serum triglyceride levels > 200 mg/dl and in a sex-specific subsample of 81 white persons of each sex with normal triglyceride levels who gave a second specimen of larger volume for this purpose. Twenty-eight (35%) of the normotriglyceridemic women were taking sex steroids.

Lipid measurements

The cholesterol and triglyceride concentrations in the whole serum and lipoprotein fractions were determined on the fresh serum by an automated technique (19). The cholesterol values were adjusted to Abell-Kendall equivalent units through a calibrator serum pool supplied by the Lipid Standardization Laboratory at the Centers for Disease Control, Atlanta, GA. The lipoprotein fractions were separated by preparative ultracentrifugation as previously described (20).

ApoE measurements

ApoE was measured by radioimmunoassay as previously described (6) in serum stored at −20°C from 2 to 5 years.[1] The frozen serum came from the same spec-

[1] No systematic variation in apoE levels was found over a period of 3 years in a serum pool frozen at −20°C.

imen on which the lipid measurements were made. Specimens from all five sample groups were assayed on each run.

Apolipoprotein composition of VLDL

Our methods of quantitative measurement of the apolipoproteins of VLDL have been described elsewhere (21). The VLDL fraction was separated by preparative ultracentrifugation and then concentrated by a second ultracentrifugation. The denaturing solvent 1,1,3,3-tetramethylurea (TMU) was used to delipidate VLDL and selectively precipitate apoB. ApoB was expressed as a percentage of total protein; apoE was expressed as a percentage of TMU-soluble protein. The content of apoE detected in VLDL in this study is appreciably lower than originally reported (21) owing to the use of improved chromagenicity data obtained on highly purified apoE.

Statistical analysis

It was assumed that serum apoE level was a function of VLDL concentration and would covary with the cholesterol and triglyceride levels in the VLDL fraction as well as serum triglyceride level. To determine whether serum apoE level varied among the five sample groups independently of VLDL level, the slope of the regression of serum apoE on each one of these three lipid indicators of VLDL concentration was first computed for each sample group by the method of least squares. The group-specific slopes for each indicator were then evaluated for parallelism by the F ratio and the group-specific mean levels of serum apoE were adjusted by analysis of covariance.

Four between-groups comparisons of the adjusted mean levels were made: selected versus unselected men; women not taking sex steroids versus unselected men; contraceptive drug users versus nonusers of sex steroids; and women receiving estrogens without progestins versus nonusers. Bonferroni's inequality was used to assure that the alpha error rate for the set of four comparisons did not exceed 0.05 (22). The ratio (Z) of the mean difference to its standard error required for statistical significance was 2.50.

The group-specific Y-intercepts of the regression of serum apoE on the lipid indicators of VLDL concentration provide estimates of the mean level of apoE not associated with VLDL. These estimates will be biased if the relationship of serum apoE to the predictor is not linear. Bias from lack of fit with the linear model was evaluated by comparing the residual mean square from the linear model with that from alternative models and by examination of the residuals. No alternative model giving a better fit was found and no evidence of curvature was shown by the residuals.

The estimate of the Y-intercept will also be biased if the estimate of the slope of the regression is biased toward zero by measurement error in the predictor. Bartlett's method of fitting a straight line when both dependent and independent variables are subject to measurement error (23) was also used to estimate the regression coefficients. In this alternative to least squares estimation, the coefficient for the slope (b) is found as $(\bar{Y}_3 - \bar{Y}_1)/(\bar{X}_3 - \bar{X}_1)$, where $\bar{X}_1$ and $\bar{X}_3$ denote the respective means of the first and third tertiles in the independent variable and $\bar{Y}_1$ and $\bar{Y}_3$ denote the respective means of the corresponding values of the dependent variable. The Y-intercept is then found as $\bar{Y} - b\bar{X}$, where $\bar{Y}$ and $\bar{X}$ denote the respective means of the dependent and independent variables.

Partial coefficients of correlation were used to evaluate the covariance between serum apoE and the level of cholesterol in the LDL and HDL fractions within a sample group independent of any mutual covariance with VLDL lipid levels.

RESULTS

Serum apoE levels

Women not taking exogenous sex steroids tended to have higher serum apoE levels than men unselected with respect to serum triglyceride level (**Table 2**). The mean sex difference of 0.95 mg/dl was statistically significant. Mean serum apoE level increased with age in both sexes but was higher in women than in men at all ages (Table 2). The sex-specific age trends in serum apoE level corresponded to concomitant age trends in VLDL lipid levels.

Serum apoE levels were generally lower among women taking contraceptive drugs than among other women of the same age (**Table 3**). The mean difference of 0.99 mg/dl between contraceptive drug users and nonusers of the same age was statistically significant. Women taking estrogens without progestins also tended

TABLE 2. Serum apolipoprotein E levels by sex and age

	Women[a]		Men[b]		Sex Difference	
Age	Mean	SD	Mean	SD	Mean	SEM
yr			*mg/dl*			
20–34	(29) 5.01	1.47	(27) 4.14	1.31	0.87	0.38
35–49	(27) 5.72	2.12	(30) 5.27	1.75	0.45	0.53
50–64	(30) 6.42	1.98	(29) 5.29	1.80	1.12	0.48
20–64	(86) 5.89	2.37	(86) 4.94	1.70	0.95	0.32

[a] Not taking sex steroids.
[b] Unselected with respect to triglyceride level.
SD, standard deviation; SEM, standard error of the mean. The number of subjects in each age group is in parentheses.

TABLE 3. Serum apolipoprotein E levels in users and nonusers of sex steroids

Age	Users		Nonusers		User Difference	
	Mean	SD	Mean	SD	Mean	SEM
yr			*mg/dl*			
20–39	(31)[a] 4.05	1.41	(36) 5.04	1.48	−0.99	0.36
45–64	(18)[b] 5.94	2.74	(40) 6.47	2.08	−0.53	0.73

[a] Taking contraceptive drugs.
[b] Taking estrogens without progestins.
SD, standard deviation; SEM, standard error of the mean. The number of women in each group is in parentheses.

to have lower serum apoE levels than other women of like age (Table 3), but the observed mean difference of 0.53 mg/dl was not statistically significant.

The mean serum apoE level of the group of men selected for hypertriglyceridemia (9.67 mg/dl) was twice that of men unselected with respect to serum lipid levels (4.95 mg/dl).

Relationship with VLDL lipid levels

In all five sample groups, serum apoE level tended to increase linearly with each of the three lipid indicators of VLDL concentration: VLDL-cholesterol, VLDL-triglycerides, and serum triglycerides. The observed group-specific slopes of the regression of apoE on each indicator of VLDL concentration were similar (**Table 4**) and statistically homogeneous ($F < 0.30$). VLDL-cholesterol generally accounted for a somewhat larger proportion of the within-group variation in serum apoE level than either VLDL- or serum-triglycerides (Table 4) and yielded the smallest residual mean square for the pooled data.

When adjusted for VLDL-cholesterol level, the mean difference in serum apoE level between selected and unselected men was reduced from 4.7 mg/dl to a nonsignificant 0.3 mg/dl (standard error = 0.5), but the mean difference between women and men increased to 1.4 mg/dl (standard error = 0.3). Adjustment for VLDL-cholesterol level also increased the mean difference in serum apoE level between contraceptive drug users and nonusers of sex steroids to 1.9 mg/dl (standard error = 0.4). The apoE levels of women taking estrogens without progestins were on average only 0.3 mg/dl lower than those of other women having like VLDL-cholesterol levels but not receiving sex steroids. This adjusted mean difference was not statistically significant ($z < 0.6$). Adjustment for the triglyceride level in the whole serum or VLDL fraction yielded comparable results.

Table 5 gives the pooled estimate of the slope of the regression of serum apoE on each lipid indicator of VLDL concentration and the estimates of the Y-intercept. Regardless of the indicator used, the regression line intercepted the Y axis at values substantially greater than zero in all classes of persons. The bias in these estimates from measurement error in the lipid determinations was relatively small. **Table 6** compares the regression coefficients obtained by the method of least squares with those obtained by Bartlett's alternative method in the two primary sample groups. Although the alternative method yielded a larger coefficient for the slope, the difference was not large enough to lower the Y-intercept appreciably.

ApoE constituted approximately 12% of the TMU-soluble VLDL protein in the groups studied for apolipoprotein composition. This proportion was independent of VLDL-triglyceride level, sex, and the use of sex steroids (**Table 7**). When corrected for apoB, which constituted approximately 45% of the VLDL protein, apoE represented 6.6% of the total protein. Assuming that the ratio of triglycerides to protein for VLDL is on average 5:1 (24), then serum apoE level should increase, on the average, by 0.0132 mg/dl for each 1 mg/dl increase in VLDL-triglyceride level. This estimate of the functional relationship between apoE and VLDL-triglycerides agrees closely with the estimate derived by least squares regression (Table 5).

TABLE 4. Simple regression of serum apolipoprotein E (mg/dl) on each indicator of VLDL concentration: VLDL-cholesterol, VLDL-triglyceride, and serum triglyceride (mg/dl)

Sample Group	VLDL-Cholesterol			VLDL-Triglyceride			Serum Triglyceride		
	b	SE	R^2	b	SE	R^2	b	SE	R^2
Men									
Unselected	0.0755	0.0110	0.359	0.0145	0.0024	0.310	0.0139	0.0020	0.357
Triglycerides > 200mg/dl	0.0700	0.0084	0.586	0.0125	0.0023	0.378	0.0118	0.0021	0.393
Women									
No exogenous sex steroids	0.0852	0.0284	0.096	0.0102	0.0063	NS	0.0106	0.0053	0.046
Contraceptive drugs	0.0866	0.0451	NS	0.0146	0.0019	NS	0.0097	0.0097	NS
Estrogen alone	0.0420	0.0548	NS	0.0119	0.0150	NS	0.0071	0.0120	NS

b, slope; SE, standard error of b; R^2, proportion of variation due to regression; NS, not statistically significant.

TABLE 5. Pooled estimates of the coefficients of regression of serum apoE (mg/dl) on lipid indicators of VLDL level (mg/dl)

Indicator	Common Slope (b) and its Standard Error (SE)		Y-intercept (a) and its Standard Error (SE)							
			Men[a]		Women No Exogenous Sex Steroids		Women Contraceptive Drugs		Women Estrogen Alone	
	b	SE	a	SE	a	SE	a	SE	a	SE
VLDL-cholesterol	0.0732	0.0041	3.67	0.20	5.07	0.24	3.17	0.39	4.76	0.50
VLDL-triglycerides	0.0127	0.0015	3.96	0.21	5.32	0.25	3.50	0.40	5.19	0.51
Serum triglycerides	0.0120	0.0013	3.56	0.22	4.88	0.26	2.93	0.40	4.58	0.52

[a] Whether selected or unselected with respect to serum triglyceride level.

Relationship with LDL and HDL lipid levels

Serum apoE level, controlled for VLDL-cholesterol, covaried with the levels of cholesterol in the LDL and HDL fractions in both sample groups of men (**Table 8**). A similar but nonsignificant trend was also displayed by women not taking sex steroids (Table 8).

DISCUSSION

The major protein components of VLDL are the B, C, and E apoproteins (21). Each of these proteins has important functions in the metabolism of this lipoprotein class. Although our earlier studies and those of others have shown that the level of serum apoE is increased in hypertriglyceridemia and is a direct function of serum or VLDL triglyceride levels in healthy persons (5–7), the present study provides the first systematic analysis of the relationship between VLDL levels and serum apoE levels. This analysis indicates that serum apoE level increases on average by 0.013 mg/dl with each 1 mg/dl increase in VLDL-triglycerides irrespective of sex, but is 1.4 mg/dl higher in women than in men with the same VLDL-triglyceride level.

Our estimates of the Y-intercept of the regression of serum apoE on the lipid indicators of VLDL (Table 5) suggest that only a small part of the apoE in the serum of the average person is in the VLDL fraction. For the average man, with a VLDL-triglyceride level of 77 mg/dl (Table 1) and a serum apoE level of 4.9 mg/dl (Table 2), only about 20% (approximately 1 mg) would be in the VLDL fraction. For the average women, with her lower level of VLDL-triglycerides but higher level of serum apoE, this proportion would be even smaller at approximately 10%. Consequently, VLDL level accounted for a much smaller proportion of the variation in serum apoE level among women than among men (Table 4).

These estimates of the amount of serum apoE associated with VLDL particles are based on a linear relationship between serum apoE level and VLDL concentration. No alternative model gave a better fit to the data and no evidence of curvature was shown by examination of the residuals. A linear relationship is also consistent with the observation that apoE constituted the same fraction of apoVLDL in normotriglyceridemic and hypertriglyceridemic men. ApoE is known to transfer to chylomicrons from other lipoproteins during alimentary lipemia (12, 13) and it is quite possible that

TABLE 6. Comparison of regression coefficients using method of least squares and Bartlett's method

Independent Variable	Method of Least Squares		Bartlett's Method	
	Intercept	Slope	Intercept	Slope
VLDL-cholesterol				
Men[a]	3.57	0.0755	3.44	0.0830
Women[b]	4.90	0.0852	4.65	0.1068
VLDL-triglycerides				
Men	3.82	0.0145	3.52	0.0186
Women	5.43	0.0102	4.94	0.0209
Serum triglycerides				
Men	3.34	0.0139	3.16	0.0156
Women	5.00	0.0106	4.48	0.0167

[a] Unselected with respect to triglycerides.
[b] Not taking sex steroids.

TABLE 7. Percentage of TMU-soluble VLDL protein represented by apolipoprotein E

Persons Measured for Apolipoprotein Composition	Percent ApoE	
	Mean	SD
Men		
Normotriglyceridemic (81)	12.2	4.2
Hypertriglyceridemic (156)	11.9	3.9
Women (normotriglyceridemic)		
No exogenous sex steroids (53)	12.6	4.6
Contraceptive drugs (10)	12.0	3.2
Estrogens without progestins (18)	11.7	5.0

The number of subjects in each group is in parentheses.

TABLE 8. Partial coefficients of correlation between serum apolipoprotein E and LDL- and HDL-cholesterol, controlled for VLDL-cholesterol

Subjects	LDL Cholesterol	HDL Cholesterol
Men		
Unselected	0.399[a]	0.237[b]
Triglycerides > 200 mg/dl	0.447[a]	0.290[b]
Women		
No exogenous sex steroids	0.111 NS[c]	0.130 NS[c]

[a] $P < 0.01$.
[b] $P < 0.05$.
[c] NS, not significant; $P > 0.10$.

the amount of apoE in lipoproteins other than VLDL is an inverse function of VLDL level in fasting persons. This should yield curvature in the regression of apoE upon VLDL-triglycerides, but it might be too slight to detect with our sample size. It should be noted that even a small degree of curvature would inflate our estimates of both the Y-intercept and the adjusted sex difference in apoE level.

Nonetheless, our data strongly suggest that women not taking gonadal steroids have considerably more apoE than men in lipoproteins other than VLDL. The higher serum apoE levels of women, despite their lower VLDL levels, cannot be attributed to compositional differences in apoVLDL between sexes. Our compositional studies of isolated VLDL, as well as the regression analysis, indicated that apoE constituted the same fraction of apoVLDL in both sexes.

The serum apoE and VLDL-lipid levels of women taking estrogens without progestins were comparable to those of women of the same age not taking gonadal steroids. On the other hand, serum apoE levels of women using contraceptive steroids were substantially lower than those of nonusers, although their VLDL-triglyceride levels were, on the average, 14 mg/dl higher than those of nonusers of the same age, and their VLDL apparently contained the same amount of apoE. It seems, therefore, that women receiving synthetic progestins together with synthetic estrogens may have substantially lower concentrations of particles, other than VLDL, that contain apoE. The effects of contraceptive drugs on plasma lipoproteins have been found to vary with the specific estrogen-progestin formulation (25, 26). The numbers of women in our sample of contraceptive drug users taking specific estrogen-progestin formulations other than mestranol combined with norethindrone were too small to detect heterogeneous effects among preparations on serum apoE level.

Studies in rats also provide evidence of sex hormone-related differences in plasma apoE levels. Patsch and associates (27) have found that apoE constitutes a larger fraction of the protein component of ultracentrifugally separated VLDL + LDL and HDL of female rats than that of male rats of the same age. Administration of estradiol to castrated males increased the content of apoE in these lipoprotein fractions, whereas administration of testosterone to castrated females had the opposite effect. Van Lenten, Jenkins, and Roheim (28) found no differences between apoE levels in plasma of age-matched male and female rats fed a fat-enriched chow, but Fainaru, Havel, and Imaizumi (1) found plasma apoE levels of female rats fed a low-fat chow to be 13% greater than that of weight-matched males, even though less apoE was found in ultracentrifugally isolated VLDL of the females.

Previous studies have shown that ultracentrifugally separated LDL and HDL contain a large fraction of serum apoE (5, 6). However, the biological significance of these observations was uncertain because some apoE dissociates from lipoproteins during ultracentrifugation (1–3, 5–7). From analyses of apoE in lipoprotein fractions separated by gel chromatography in rats and humans, most of the apoE not associated with VLDL appears to be in particles intermediate in diameter between LDL and bulk HDL (2, 5, 6, 8) that contain apoA-I as well as apoE (11).[2] Our observation that the level of serum apoE covaries with LDL and HDL-cholesterol level, independent of VLDL-cholesterol level, cannot be easily related to the concentration of apoE in a subfraction of HDL, even though the hydrated density of apoE-containing HDL particles may be close to 1.063 g/ml, so that some of these particles ("HDL_1") may be isolated with LDL as well as HDL in the preparative ultracentrifuge. It should be noted that our LDL fraction includes intermediate density lipoproteins which contain appreciable apoE (6).

ApoE in particles resembling HDL_1 may have at least two functions. Like the C apoproteins, which are also present chiefly in larger than average-sized HDL (29–31), this apoE is a reservoir available for transfer to chylomicrons and VLDL (12, 13), and thus participates in the hepatic processing of partially catabolized triglyceride-rich lipoproteins. In addition, apoE-containing HDL may participate in the transport of cholesterol from extrahepatic tissues to the liver (11, 32). In either case, this apoE could help to prevent accumulation of cholesteryl esters in arteries. Our observation that women apparently have more apoE associated with particles other than VLDL than men therefore raises the possibility that a higher level of HDL particles containing apoE is one factor that protects women from the development of atherosclerosis. It is also conceivable that the lower ambient levels of VLDL in women than

[2] By an immunoaffinity technique, it has been found that approximately 50% of the apoE in blood plasma of normotriglyceridemic humans is in particles that contain apoA-I but no apoB (Castro, G. R., and C. J. Fielding. Unpublished data).

in men is related to their larger pool of readily available apoE, and that the increase in VLDL with the use of contraceptive steroids is related to the decrease in this pool.

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