

THE EFFECT OF INCREASING AGE ON SERUM CHOLESTEROL CONCENTRATION

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Determinations of the total cholesterol concentration of the blood serum in twenty-five healthy subjects on two or more occasions over periods of time up to 28 months in length led to the conclusion that the variability of this constituent is much less within a given individual than it is among individuals, and the hypothesis was advanced that in each healthy person the serum cholesterol concentration is maintained, perhaps throughout life, at a constitutional level, from which large deviations do not occur in the absence of unusual stress (1). Other investigators (2-4) have reported findings in general agreement with this hypothesis, and strong support for it was furnished by the finding (5) that the average cholesterol concentrations in children, calculated for each year of age, did not change appreciably from the 2nd month to the 13th year of life and were almost the same as the average found in healthy adults between the ages of 19 and 43 years.

Recently Keys (6) found a considerable increase in the average serum cholesterol concentration of healthy men with increasing age, from 173 mg. per 100 ml. at 19 years to 252 mg. at 52.5 years of age, and Gram and Leverton (7) reported a similar result in women. These findings are inconsistent with the hypothesis stated above.

Because of this apparent discrepancy it seemed worth while to ascertain whether the serum cholesterol level had increased in the individual subjects of the previous study (1) during the 13 to 15 years since that investigation was carried out.

EXPERIMENTAL

During 1949 the cholesterol concentration of the blood serum was determined in twenty-two of the twenty-five subjects of the earlier investigation (1).¹ In two (Subjects 1 and 60) the determination was repeated, and in one (Subject 50) an analysis had been carried out in 1942. The methods are described in the preceding paper (8).

¹ We are deeply indebted to our colleagues who cheerfully furnished samples of their blood; particularly to the ten who participated in the investigation by preparing extracts and mailing them to us.

RESULTS AND DISCUSSION

In interpreting the results (Tables I and II) it is necessary first to consider the possible effect of changes in the Schoenheimer-Sperry method,

TABLE I
Effect of Age on Serum Cholesterol Concentration in Men

Subject No.*	Age in 1949	Average concentration in 1934-36	Results obtained in 1949			
			Procedure A†		Procedure B‡	
			Concentration	Change from 1934-36 average	Concentration	Change from 1934-36 average
	yrs.	mg. per 100 ml.	mg. per 100 ml.	per cent	mg. per 100 ml.	per cent
8	41 ^x	212	191	-9.9	196	-7.5
64	40	251	231	-8.0	236	-6.0
82	53	257	242	-5.8	243	-5.4
85	38	200	176	-12.0	191	-4.5
9	57	255	232	-9.0	245	-3.9
87	45	173	168	-2.9	171	-1.2
2	39	328	329	0.3	338	3.0
89	47	187	192	2.7	201	7.5
84	40	232	237	2.2	266	14.7
1	49	201	226	12.4	235	16.9
1			215	7.0	224	11.4
77	46	201	232	15.4	234	16.4
50	38	315	355	12.7	369	17.1
50		368‡		-3.5§		0.3§
6	51	142	157	10.6	168	18.3
60	32	175	228	30.3	223	27.4
60			208	18.9	230	31.4
Average...		224			237	

* The numbers of the subjects are the same as those used in the previous publication (1).

† Procedures A and B are described in the preceding paper (8).

‡ Analysis in 1942.

§ Change from 1942 value.

|| In calculating this average, an average of the two values for Subjects 1 and 60 was used in each case.

which was used in its original form for the earlier study. Some of the modifications, described in the preceding paper (8), were adopted to facilitate the procedure, and others to minimize the possibility of loss at various points. Thus, if the changes had any effect, it would be in the direction of increasing the values obtained in the present analyses. A more serious difficulty in interpreting the results arises from the finding that

old aqueous digitonin solutions (Procedure A) may give low results as compared with those yielded by a solution in 50 per cent alcohol (Procedure B) (8). It is possible, though unlikely (see the Discussion of the preceding paper), that the earlier determinations suffered from the same source of error, and there is some justification, therefore, for using the aqueous digitonin values (Procedure A) for comparison with the concentrations of cholesterol found about 14 years ago. For this reason the

TABLE II
Effect of Age on Serum Cholesterol Concentration in Women

Subject No.*	Age in 1949	Average concentration in 1934-36	Results obtained in 1949			
			Procedure A*		Procedure B*	
			Concentration	Change from 1934-36 average	Concentration	Change from 1934-36 average
	yrs.	mg. per 100 ml.	mg. per 100 ml.	per cent	mg. per 100 ml.	per cent
88	45	202	188	-6.9	213	5.4
86	54	211	225	6.6	232	10.0
70	41	198	223	12.6	244	23.2
72	46	177	207	16.9	219	23.7
71	35	171	215	25.7	220	28.7
83	53	198	227†	14.6	257†	32.1
69	45	162	204	25.9	214	32.1
73	46	182	229	25.8	241	32.4
Average		188			230	

* See Table I.

† This sample of serum had stood for some time at room temperature in a tightly stoppered sterile tube before extraction. The percentage of free in total cholesterol was decreased due to esterification, as would be expected, but since the total cholesterol concentration does not change under these conditions (9), the analysis is included.

values yielded by Procedures A and B are both given in Tables I and II. Actually, the interpretation of the results would not be affected in most of the subjects if the comparison were based on the results of Procedure A.

In the first eight men, as listed in Table I, the cholesterol concentration had not changed appreciably from the average found in 1934-36. Variations of the magnitude found in these subjects have been observed in fasting men during a single morning. In the remaining six men there appear to have been definite increases which were confirmed in two. The average concentration for all of the men was 5.8 per cent higher than the average of the values found in the earlier study. Over a correspond-

ing range of age Keys (6) found an increase in average cholesterol concentration of about 17 per cent, as estimated from a curve plotted from his data.

By contrast to the findings in men, in most of the women there appears to have been a definite increase in serum cholesterol concentration during the period of life studied. The increase, calculated from average concentrations, was 22.7 per cent as compared with an increase, estimated from the data of Gram and Leverton (7), of about 14 per cent over the same life span.

The results lead to two conclusions: The concentration of cholesterol in the blood serum is not maintained by all individuals within as narrow a range as had been thought; in some there is an increase with age, as was indicated by the findings of Keys and of Gram and Leverton. But conversely, the results show that the increase is not an obligatory concomitant of aging, at least over the period of life studied in this investigation.

SUMMARY

The cholesterol concentration of the blood serum was determined in fourteen men and eight women, and the values were compared with those found in the same subjects 13 to 15 years before. In eight of the men and one of the women no appreciable change had occurred, in one woman the result was indecisive, and in six men and six women increases from about 15 to 30 per cent were found. It is concluded that the serum cholesterol concentration increases with age in some persons, but the increase is not an obligatory concomitant of aging.

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