

# Serum Lipid Levels Among Rural Guatemalan Indians

JOSÉ MÉNDEZ, PH.D.,\* CARLOS TEJADA, M.D.† AND MARINA FLORES, M.S.‡

SERUM cholesterol levels in adult Guatemalan Indians have been found to be very low as compared with values reported for the urban, non-Indian population in the upper income groups of Guatemala City and the population of North America and some European countries.<sup>1-6</sup> The low serum cholesterol values observed in the Guatemalan Indians and in many population groups throughout the world appear to be associated with a low fat consumption and with a low incidence of coronary heart disease.<sup>4,7,8</sup> Conversely, in population groups consuming large amounts of fat, especially saturated lipids, serum cholesterol levels and mortality rates due to coronary heart disease are higher.<sup>3-6</sup> Up to fifty years of age, cholesterol levels are usually higher in men than women, a finding which also parallels the higher incidence of myocardial infarction commonly observed among men. However, the often reported increases in serum cholesterol concentration with age<sup>9,10</sup> are not found in all population groups.<sup>11-13</sup>

In Guatemala about 54 per cent of the total population of 3.5 millions are classified as Indians. The majority of them live under relatively primitive conditions in small communities scattered throughout the country. They are divided into various groups, but

their food habits are usually characterized by low fat consumption and low intakes of animal protein, vitamin A and riboflavin.<sup>1,2,14,15</sup>

Although the apparent hypocholesterolemia of the Guatemalan Indian has previously been studied only in limited surveys in communities near Guatemala City<sup>1,2,14,15</sup> easily accessible by road, serum total lipids and lipid phosphorus values have not been reported. In the present survey the cholesterolemia was examined and the total serum lipids and lipid phosphorus levels were determined in Mayan Indians from all the principal linguistic groups identified in Guatemala. The effect of age, sex and certain other variables was measured.

## MATERIALS AND METHODS

Blood samples were collected in twenty-three Mayan Indian communities in Guatemala from 167 male and eighty-four nonpregnant female Indians, ten to eighty years of age. Anthropologic information permitted the grouping of the communities into seven linguistic subgroups according to customs and language. Each of the four principal linguistic groups in the country, Quiché, Mam, Pocomam and Chol, were represented by one or more of these subgroups. The communities surveyed and their linguistic classification are shown in Figure 1. The communities were selected with the technical advice and field cooperation of the "Instituto Indigenista de Guatemala," as described by Tejada et al.<sup>16</sup> in their report on the concomitant study of the distribution of blood antigens among Guatemalan Indians.

In each community, blood samples were collected from an average of ten subjects taken at random. All persons possessed the following characteristics: (1) personal recognition of status as an Indian, (2) wearing of native costume and (3) use of an Indian dialect. Serum total lipids were determined by the method of Bragdon,<sup>17</sup> lipid phosphorus by the method of Chen et al.<sup>18</sup> and total cholesterol

---

From the Institute of Nutrition of Central America and Panama (INCAP), Guatemala, C. A. INCAP Publication I-215.

\* Chief, Division of Physiology and Director of Training; † Chief, Division of Clinical Pathology and Pathological Anatomy; ‡ Chief, Nutrition Surveys Section.

This investigation was supported by Grants 266 from the Nutrition Foundation and H-2653 from the National Heart Institute of the National Institutes of Health, U. S. Public Health Service.

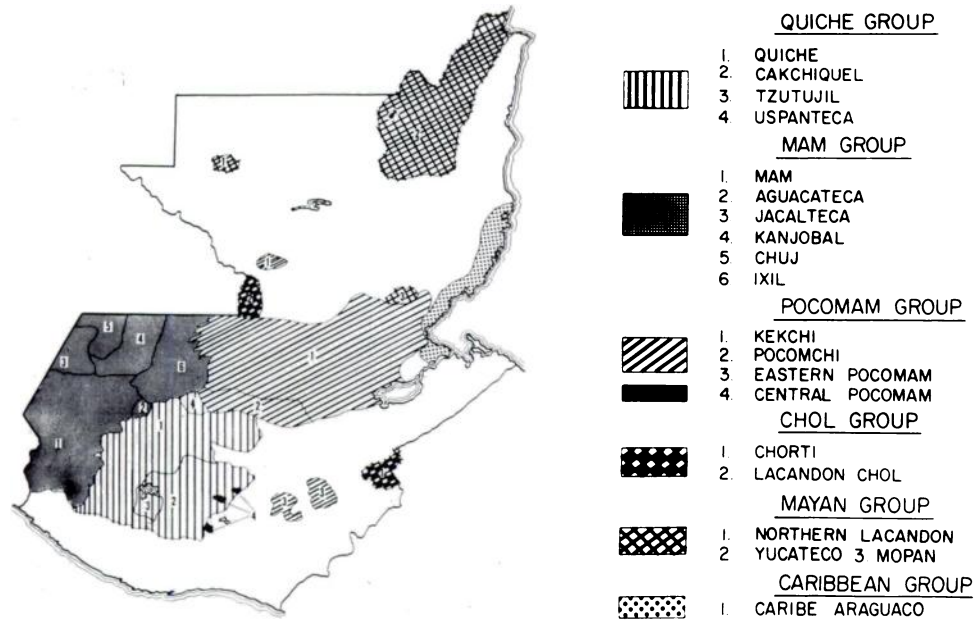


FIG. 1. Map of present Indian linguistic groups of Guatemala. Compiled by Goubaud Carrera, A.<sup>21</sup> and Arriaga, A.

by the method of Abell et al.<sup>19</sup> adapted for micro-methods.

Information on the daily dietary intake was available from previous surveys by INCAP<sup>14,15,20</sup> and by Goubaud Carrera.<sup>21</sup> The food composition tables prepared by INCAP<sup>22</sup> were used to calculate

the nutritional value of the diets, and data of Goubaud Carrera were recalculated by standard INCAP procedures. In calculating the daily intake of fatty acids, the composition tables of Hardinge and Crooks,<sup>23</sup> and Hayes and Rose<sup>24</sup> were employed.

TABLE I  
Serum Total Lipids in Rural Guatemalan Indians Listed According to Age and Sex of Subjects Studied

Data	Age Groups (yr.)						
	10-19	20-29	30-39	40-49	50-59	60-80	All Ages
<i>Male</i>							
No. of cases.....	9	40	44	38	21	12	164
Mean.....	676	729	744	763	781	784	749
Standard deviation..	117	135	153	190	161	158	158
<i>Female</i>							
No. of cases.....	8	14	25	16	13	9	85
Mean.....	842	842	787	850	824	841	824
Standard deviation..	238	224	131	209	180	273	194
<i>Both Sexes</i>							
No. of cases.....	17	54	69	54	34	21	249
Mean.....	754	758	759	789	797	809	775
Standard deviation..	197	168	146	198	167	211	174

TABLE II  
Serum Lipid Phosphorus Levels in Rural Guatemalan Indians Listed According to Age and Sex of Subjects Studied

Data	Age Groups (yr.)						
	10-19	20-29	30-39	40-49	50-59	60-80	All Ages
<i>Male</i>							
No. of cases.....	9	40	44	38	21	10	162
Mean.....	5.5	6.7	7.0	7.0	7.3	6.6	6.9
Standard deviation..	1.7	1.4	1.9	1.8	1.6	1.1	1.7
<i>Female</i>							
No. of cases.....	8	13	25	17	12	9	84
Mean.....	7.0	8.8	7.8	8.3	7.4	6.9	7.9
Standard deviation..	1.8	2.7	1.4	2.1	1.4	2.6	2.0
<i>Both Sexes</i>							
No. of cases.....	17	53	69	55	33	19	246
Mean.....	6.2	7.2	7.3	7.4	7.4	7.2	7.2
Standard deviation..	1.8	2.0	1.8	2.0	1.5	2.0	1.9

## RESULTS

The total lipid, lipid phosphorus and cholesterol levels observed are tabulated according to the age and sex of the subjects

studied (Tables I, II and III). Analysis of variance showed no significant tendency for any of these measurements to increase with age in the populations studied. Although the

TABLE III  
Serum Cholesterol Levels in Rural Guatemalan Indians Listed According to Age and Sex of Subjects Studied

Data	Age Groups (yr.)						
	10-19	20-29	30-39	40-49	50-59	60-80	All Ages
<i>Male</i>							
No. of cases.....	9	43	45	37	21	12	167
Mean.....	122	131	136	129	136	126	132
Standard deviation..	30	26	32	29	25	27	28
<i>Female</i>							
No. of cases.....	8	14	24	16	13	9	84
Mean.....	126	152	138	150	140	147	143
Standard deviation..	37	39	27	39	18	44	33
<i>Both Sexes</i>							
No. of cases.....	17	57	69	53	34	21	251
Mean.....	124	136	137	135	138	135	135
Standard deviation..	33	31	30	34	22	36	31

TABLE IV  
Serum Lipid Levels in Rural Guatemalan Indians Listed According to Linguistic Group

Linguistic Groups	Subgroups	Cases (no.)	Total Lipids (mg./100 ml.)		Lipid Phosphorus (mg./100 ml.)		Cholesterol (mg./100 ml.)	
			Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Quiché	Cakchiquel	46	816	211	8.0	1.8	148	29
	Quiché	43	751	147	7.1	1.9	140	31
Mam	Ixil-Aguacateca	30	728	125	6.2	1.1	132	19
	Mam	43	720	140	6.5	1.5	122	32
Pocomam	Pocomam Central	44	756	188	7.1	1.8	135	29
	Kekchí	11	726	121	7.6	1.8	125	28
Chol	Chortí	34	892	165	8.1	2.3	138	36

TABLE V  
Serum Cholesterol Levels in Rural Guatemalan Indians Listed by Village Within Linguistic Groups

Village	No.	Serum Cholesterol (mg./100 ml.)	
		Mean	Standard Deviation
Quiché			
Nahualá.....	12	149	40
Sta. Lucía U.....	12	141	28
San Mateo.....	10	134	32
San Andrés Xecul....	9	131	18
Cakchiquel			
Sumpango.....	12	148	24
Santa María.....	10	155	30
Patzún.....	12	135	24
Comalapa.....	11	154	35
Ixil Aguacateca			
Aguacatán.....	10	131	22
Nebaj.....	10	125	19
Chejul.....	10	139	15
Mam			
San Juan O.....	11	132	43
Concepción Ch.....	12	126	25
San Pedro Sac.....	10	127	28
San Sebastián.....	10	100	17
Pocomam Central			
Palín.....	10	126	18
Chinautla.....	10	141	19
San Luis J.....	12	143	27
San Pedro Pinula....	12	130	41
Kekchí			
Lanquín.....	11	125	28
Chortí			
Olopa.....	12	150	39
Jocotán.....	11	136	39
Camotán.....	11	125	29

concentration in serum lipid fractions encountered in women in all age groups was greater, this difference was not significant for cholesterol and total lipids when adjusted for unequal proportions of each sex represented in the samples from the different linguistic groups.

As shown in Table IV, significant differences in serum lipid fractions among linguistic groups were observed. The highest averages for total lipids, lipid phosphorus and cholesterol were 892, 8.1 and 148 mg. per 100 ml., respectively, and the lowest 720, 6.2 and 122 mg. per 100 ml. The serum cholesterol levels determined in subjects in the individual villages are presented in Table V. In one village the average of serum cholesterol level was 100 mg. per 100 ml., in six villages it was between 121 and 130, in eight between 131 and 140, in six between 141 and 150, and in two over 150 mg. per 100 ml. The cholesterol:phospholipid ratios among adults varied from 0.69 to 0.85. The cholesterol:phospholipid ratio for all age groups was 0.77 for males, 0.72 for females and 0.75 for the group as a whole.

The daily dietary intake of the Guatemalan rural Indian groups studied are presented in Table VI. No dietary information in the Quiché linguistic subgroup was available. Although the dietary information was not directly obtained in the present study, it was taken as representative for the groups surveyed. The amount of fat consumed was very low and only



TABLE VI  
Daily Dietary Intake of Rural Guatemalan Indians Listed by Linguistic Groups

Dietary Intake	Quiché Cakchiquel	Chol Chortí	Mam		Pocomam	
			Ixil Aguacateca	Mam	Pocomam Central	Kekchí
Calories.....	2,259	2,144	2,214	2,279	2,089	2,037
Total protein (gm.).....	69.6	67.6	66.6	78.0	64.1	62.7
Animal protein (gm.).....	6.6	5.4	5.2	15.5	8.8	9.5
Carbohydrate (gm.).....	458.9	428.9	448.6	454.4	420.6	416.5
Fat (gm.).....	18.3	20.2	18.4	20.1	19.0	16.1
Per cent calories.....	7.3	8.5	7.5	7.9	8.2	7.1
Fat derived from corn.....	9.7	6.4	11.4	11.1	8.9	7.2
Fatty acids						
Saturated (gm.).....	3.5	5.8	3.5	4.3	4.5	3.8
Per cent calories.....	1.4	2.4	1.4	1.7	1.9	1.7
Monounsaturated (gm.).....	7.7	7.6	7.6	8.0	7.5	6.5
Per cent calories.....	3.1	3.2	3.1	3.2	3.2	2.9
Polyunsaturated (gm.).....	5.0	4.8	5.8	5.6	5.2	3.8
Per cent calories.....	2.0	2.0	2.4	2.2	2.2	1.7

contributed 7 to 8 per cent to the total caloric intake. The dietary pattern was very consistent among all groups. It is interesting to observe that saturated, oleic and essential fatty acids contributed 1.8, 3.1 and 2.1 per cent to the caloric intake, respectively.

#### COMMENTS

Neither cholesterol, lipid phosphorus nor total lipid levels were found to vary significantly with age among rural Guatemalan Indians. In many other populations, cholesterol values tend to increase with age,<sup>9,10</sup> although this is not always the case.<sup>11-13</sup>

Up to fifty years of age serum cholesterol levels generally have been higher among men than among women,<sup>9</sup> although in some population groups from underdeveloped areas the reverse has been true.<sup>25,26</sup> In the present study, the cholesterol levels did not seem to be higher in women than in men.

It is noteworthy that in the present series cholesterol levels were found to be higher among linguistic groups considered to be more exposed to modern culture. For instance, the Cakchiquel group, living relatively near Guatemala City and having more contact with urban life, had a cholesterol level of 148 mg. per 100 ml., whereas the Mam group, with a level of 122 mg. per 100 ml., and the

Kekchí, with 125 mg. per 100 ml., live in the most isolated communities included in the survey. Because of the relatively small size of the subsamples studied, the statistical significance of this observation is uncertain.

There is general agreement that there is a causative relationship between diet and serum lipid levels. That quantity and quality of dietary fat can influence the serum cholesterol seems to be definite, but this is only one of a number of dietary variables which may influence serum lipid levels in a population. The dietary information collected among the rural Guatemalan Indians shows little variation in the intake of nutrients, except vitamins A and C, in all groups studied. The amount of fat in the diet contributed only from 7.1 to 8.5 per cent of the total calories. Serum cholesterol levels in population groups with similar fat consumption have always been low.<sup>5,6,25</sup> Although the total fat intake of the rural Guatemalan Indian is extremely low, the dietary intake of essential fatty acids appears satisfactory, probably because most of the fat is corn oil. Furthermore, clinical surveys have not revealed any signs of essential fatty acid deficiency among Guatemalan Indian children.

Even though serum cholesterol levels among population groups showing a low incidence of

coronary heart disease have been low,<sup>5-8</sup> and this measurement has been considered to have some prediction value for patients with coronary disease,<sup>4</sup> there is still conflicting evidence as to the relation of serum cholesterol levels to atherogenesis and the progression of atherosclerosis in man.<sup>27</sup>

From studies of patients with coronary disease it also appears that the cholesterol: phospholipid ratio is of some importance in the pathogenesis of atherosclerosis. For normal persons values between 0.70 and 0.90 have been reported; these values in patients suffering from coronary artery disease are as high as 0.85 and 1.10.<sup>28,29</sup> The cholesterol and lipid phosphorus levels observed among rural Guatemalan Indians are markedly lower than those given for normal persons in the United States,<sup>5,6</sup> although the cholesterol: phospholipid ratios in all age groups are within normal limits. These findings are in agreement with the lower incidence of complicated atherosclerotic lesions reported postmortem.<sup>7,8</sup>

The results presented herein add more evidence to support the position that a relationship exists between lipid levels and dietary factors on the one hand and atherosclerosis on the other. The cooperative studies of the geographic epidemiology of atherosclerosis now in progress, uniformly and simultaneously in several countries, take into consideration many of the suspected variables.<sup>30</sup> The results should help to clarify part of this intricate problem.

#### SUMMARY

The average serum total lipids, lipid phosphorus and cholesterol levels among 251 rural Guatemalan Indians, aged ten to eighty years, from seven Mayan linguistic groups were 775 (standard deviation 174), 7.2 (standard deviation 1.9) and 135 (standard deviation 31) mg. per 100 ml. Although lipid levels were higher in Indian women than in men, this difference was not statistically significant when corrected for disproportionate samples from some linguistic groups. No significant increases were observed with age. Dietary surveys show a fat intake from 7.1 to 8.5 per cent of the total daily calories. Cho-

lesterol levels in urban Guatemalans in the upper income groups were much higher than those observed in rural Guatemalan Indians. The cholesterol: phospholipid ratios, in all age groups, were within normal limits and averaged 0.75. The results presented herein strengthen the concept that there is a significant statistical association among serum lipid levels, dietary factors and the severity of atherosclerosis.

#### ACKNOWLEDGMENT

We are greatly indebted to the Instituto Indigenista de Guatemala for its assistance in this project. Special thanks are due to Miss Berta García for the dietary calculations, and to Mr. Rolando Funes and Mr. Carlos Enrique Amézquita for the serum lipid determinations.

#### REFERENCES

1. MANN, G. V., MUÑOZ, J. A. and SCRIMSHAW, N. S. The serum lipoprotein and cholesterol concentrations of Central and North Americans with different dietary habits. *Am. J. Med.*, 19: 25, 1955.
2. SCRIMSHAW, N. S., TRULSON, M., TEJADA, C., HEGSTED, D. M. and STARE, F. J. Serum lipoprotein and cholesterol concentrations. Comparison of rural Costa Rican, Guatemalan and United States populations. *Circulation*, 15: 805, 1957.
3. STAMLER, J. The problem of elevated blood cholesterol. *Am. J. Pub. Health* (supp. March), 50: 14, 1960.
4. KEYS, A. Prediction and possible prevention of coronary disease. *Am. J. Pub. Health*, 43: 1399, 1953.
5. MATTILL, H. I. Cholesterol as related to atherosclerosis. A review of the literature 1950 to July 1957. Chicago, 1957. Cereal Institute, Inc.
6. MATTILL, H. I. Cholesterol as related to atherosclerosis. A review of the literature July 1957 to July 1958. Chicago, 1958. Cereal Institute, Inc.
7. TEJADA, C. and GORE, I. Comparison of atherosclerosis in Guatemala City and New Orleans. *Am. J. Path.*, 33: 887, 1957.
8. TEJADA, C., GORE, I., STRONG, J. P. and MCGILL, H. C. Comparative severity of atherosclerosis in Costa Rica, Guatemala and New Orleans. *Circulation*, 18: 92, 1958.
9. LEWIS, L. A., OLMSTEAD, F., PAGE, I. H., LAWRY, E. Y., MANN, G. V., STARE, F. J., HANING, M., LAUFFER, M. A., GORDON, T. and MOORE, F. E. Serum lipid levels in normal persons. Findings of a cooperative study of lipoproteins and atherosclerosis. *Circulation*, 16: 227, 1957.
10. KEYS, A., MICKELSEN, O., MILLER, E. v. O., HAYES, E. R. and TODD, R. L. The concentration of cholesterol in the blood serum of normal man and its relation to age. *J. Clin. Invest.*, 29: 1347, 1950.

11. PAGE, I. H., KIRK, E., LEWIS, W. H., JR., THOMPSON, W. R., and VAN SLYKE, D. D. Plasma lipids of normal men at different ages. *J. Biol. Chem.*, 111: 613, 1935.
12. SPERRY, W. M. and WEBB, M. The effect of increasing age on serum cholesterol concentration. *J. Biol. Chem.*, 187: 107, 1950.
13. MAN, E. B. and PETERS, J. P. Variations of serum lipids with age. *J. Lab. & Clin. Med.*, 41: 738, 1953.
14. MÉNDEZ, J., SCRIMSHAW, N. S., ASCOLI, W. and GUZMÁN, M. A. Factors influencing serum cholesterol levels of Central American children. I. Effect of adding fat and animal protein to the diet. *Am. J. Clin. Nutrition*, 9: 143, 1961.
15. MÉNDEZ, J., SCRIMSHAW, N. S., FLORES, M., LEÓN, R. DE and BÉHAR, M. Factors influencing serum cholesterol levels of Central American children. II. The effect of gross dietary changes. *Am. J. Clin. Nutrition*, 9: 148, 1961.
16. TEJADA, C., SÁNCHEZ, M., GUZMÁN, M. A., BREGNI, E. and SCRIMSHAW, N. S. Distribution of blood antigens among Guatemalan Indians. *Human Biol.*, in press.
17. BRAGDON, J. H. Colorimetric determination of blood lipids. *J. Biol. Chem.*, 190: 513, 1951.
18. CHEN, P. S., JR., TORIBARA, T. Y. and WARNER, H. Microdetermination of phosphorus. *Anal. Chem.*, 28: 1756, 1956.
19. ABELL, L. L., LEVY, B. B., BRODIE, B. B. and KENDALL, F. E. A simplified method for the estimation of total cholesterol in serum and demonstration of its specificity. *J. Biol. Chem.*, 195: 357, 1952.
20. FLORES, M. and REH, E. Estudios de hábitos dietéticos en poblaciones de Guatemala. I. Magdalena Milpas Altas. *Bol. Ofic. san panam* (supp. 2), p. 90, 1955.
21. GOUBAUD CARRERA, A., Instituto Indigenista Nacional de Guatemala. Unpublished data, 1944.
22. Instituto de Nutrición de Centro América y Panamá. Tercera edición de la tabla de composición de alimentos de Centro América y Panamá. *Bol. Ofic. san panam*. (suppl. 1), p. 129, 1953.
23. HARDINGE, M. G. and CROOKS, H. Fatty acid composition of food fats. *J. Am. Dietet. A.*, 34: 1065, 1958.
24. HAYES, O. B. and ROSE, G. Supplementary food composition table. *J. Am. Dietet. A.*, 33: 26, 1957.
25. LUYKEN, R. and JANSEN, A. A. J. The cholesterol level in the blood serum of some population groups in New-Guinea. *Trop. Geogr. Med.*, 12: 145, 1960.
26. ROELS, O. A., MANN, G. V., MERRILL, J. and TROUT, M. Serum lipids of Congo Pygmies. *Fed. Proc.*, 20: 368f, 1961.
27. PATERSON, J. C., CORNISH, B. R. and ARMSTRONG, E. C. The serum lipids in human atherosclerosis. An interim report. *Circulation*, 13: 224, 1956.
28. GERTHER, M. M. and GARN, S. M. Lipid interrelationships in health and in coronary artery disease. *Science*, 112: 14, 1950.
29. OLIVER, M. F. and BOYD, G. S. The circulating lipids and lipoproteins in coronary artery disease. *Postgrad. M. J.*, 33: 2, 1957.
30. Interamerican Atherosclerosis Project No. AMRO 54.47. Guatemala, C. A., 1959. Instituto de Nutrición de Centro América y Panamá.
31. GOUBAUD CARRERA, A. Distribución de las lenguas indígenas actuales de Guatemala. *Bol. Instituto Indigenista*, Guatemala, 1 (2-3). 5, 1946.

