Serum Lipids in South African Bantu and White Subjects

B. M. BLOOMBERG, M.D., F. LAZARUS, B.Sc., IRENE MROST, B.A., and RHODA SCHNEIDER, B.Sc.

Normal South African Bantu differ from white Europeans in lipoprotein pattern as well as in total serum cholesterol. Urban Bantus have higher \(\alpha\)-lipoprotein cholesterol concentrations and lower \(\beta\)-lipoprotein cholesterol than whites. Young rural Bantus have lower \(\alpha\)-lipoprotein cholesterol than young urban Bantus, and both have lower \(\beta\)-lipoprotein cholesterol than old urban Bantus. These differences may be related to standards of living and are thought to be of value in defining the "ideal" levels for both cholesterol fractions.

During the course of serum lipid studies in the different racial groups of South Africa, it became apparent that normal Bantu (Negro) subjects differed from white South Africans in lipoprotein pattern as well as in total serum cholesterol levels. The findings reported here confirm previous reports by other South African workers, but, in addition, considerably higher \(\alpha\)-cholesterols and considerably lower \(\beta\)-cholesterols were found in the urban Bantus than in the whites. Further it has been found that young urban Bantus have higher total cholesterol levels than young rural Bantus and this increase is entirely in the \(\alpha\)-lipoprotein fraction, whereas the further increase with age in the urban Bantu is confined to the \(\beta\)-lipoprotein fraction. These differences are statistically significant, despite the wide ranges, and may be of importance in defining the "ideal" values of both \(\alpha\) and \(\beta\)-lipoprotein cholesterol. The results are also briefly considered from the viewpoint of determining the "physiological" value of some of the measures proposed for the prevention or treatment of atherosclerosis and coronary thrombosis.

Material and Methods

The lipid studies are reported in 104 males, and brief comparisons are made with similar data obtained in small groups of Bantu and white females. The male subjects consisted of 38 urban Bantus, 39 rural Bantus, and 27 white men. The rural Bantu group were young individuals from tribes of Southern Africa on their first visit to the Rand Gold Mines; their blood samples were collected within a few days of their arrival in Johannesburg, during a short period of hospital treatment for seabies and other minor skin lesions. The urban Bantus consisted of detribalized subjects and were divided into 3 groups: a group of young men in domestic service in "flats" or apartments, a group of old men who were employed by a public utility transport corporation and who received wages above the usual Bantu level; and a convalescent hospital group who had been admitted to the surgical wards for hernial repairs, hemorrhoidectomies, and fractures. The white men represented a "selected" group in the sense that they had been referred by physicians for various laboratory investigations in the fasting state. The opportunity was taken to study the serum lipids and the results were correlated with the clinical diagnosis. No evidence of organic disease was found in 15 "normal" subjects, and non-vascular organic disease was diagnosed in 12 subjects. The diagnoses made in the latter group were peptic ulcer, senile osteoporosis, Addison's disease, bronchitis, gout, chronic lymphatic leukemia, leukodermia, lipomata, mycosis fungoids, duodenal ulcer, and (2 cases of) cholelithiasis.

The serum total lipids were estimated by Kunkel's method, and the total cholesterol by Pearson's method, and the lipoprotein fractions and their cholesterol components by paper electrophoresis. The \(\beta\)-lipoprotein fraction included both the dense \(\beta\)-lipoprotein band itself, and the "trail" or post-\(\beta\) or "0" fraction. All estimations were performed on serum from venous blood collected in the early morning after an overnight fast. Fasting specimens were considered essential for comparison of total lipids; in addition there may be diurnal variations in various lipid fractions and exercise may also influence the cholesterol level after meals. The analyses were carried out on the great majority of the specimens on the day of collection. The separated serum was stored at 4 C. when the estimations were delayed more than a few hours. Although storage of serum at 0 to 5 C. for periods up to 28 days is said to produce no alteration of the lipoprotein pattern or con-
TABLE 1.—Classification of Bantu and White Men According to Serum Total Lipids and Total Cholesterol Values

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of subjects</th>
<th>Age Range</th>
<th>Mean Age</th>
<th>Class 1 Normal total cholesterol, normal total lipids</th>
<th>Class 2 Normal total cholesterol, raised lipids</th>
<th>Class 3 Raised total cholesterol, raised lipids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Young rural</td>
<td>39</td>
<td>16-29</td>
<td>19</td>
<td>37 95</td>
<td>1 3</td>
<td>- -</td>
</tr>
<tr>
<td>2. Young urban</td>
<td>6</td>
<td>18-31</td>
<td>25</td>
<td>5 83</td>
<td>1 17</td>
<td>- -</td>
</tr>
<tr>
<td>3. Old urban</td>
<td>22</td>
<td>46-71</td>
<td>55</td>
<td>18 82</td>
<td>4 18</td>
<td>- -</td>
</tr>
<tr>
<td>4. Convalescent urban</td>
<td>10</td>
<td>41-56</td>
<td>45</td>
<td>9 90</td>
<td>1 10</td>
<td>- -</td>
</tr>
<tr>
<td>Bantu</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Young rural</td>
<td>77</td>
<td>16-29</td>
<td>19</td>
<td>37 95</td>
<td>1 3</td>
<td>- -</td>
</tr>
<tr>
<td>2. Young urban</td>
<td></td>
<td>18-31</td>
<td>25</td>
<td>5 83</td>
<td>1 17</td>
<td>- -</td>
</tr>
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</tr>
<tr>
<td>4. Convalescent urban</td>
<td></td>
<td>41-56</td>
<td>45</td>
<td>9 90</td>
<td>1 10</td>
<td>- -</td>
</tr>
</tbody>
</table>

* One case not classified with raised cholesterol, but normal total lipid levels.
† One case of diabetes mellitus, and 1 case of "vascular disease."
‡ No evidence of organic disease.

TABLE 2.—Serum Total Cholesterol and Lipoprotein Cholesterol Fractions in ‘‘Normocholesteremic’’ Bantu and White Men (Classes 1 and 2)*

<table>
<thead>
<tr>
<th>Group†</th>
<th>Number of Subjects</th>
<th>Total cholesterol mg. per 100 ml.</th>
<th>ω-Lipoprotein cholesterol mg. per 100 ml.</th>
<th>% Total</th>
<th>β-Lipoprotein cholesterol mg. per 100 ml.</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range Mean ± S.D.</td>
<td>Range Mean ± S.D.</td>
<td>Range Mean ± S.D.</td>
<td>Range Mean ± S.D.</td>
<td>Range Mean ± S.D.</td>
</tr>
<tr>
<td>Bantu</td>
<td>74</td>
<td>87-238 145±38 3-72 30±15 2-46 21±9</td>
<td>54-200 115±33 54-98 79±9</td>
<td>61-19 36±11</td>
<td>81-162 113±33 51-81 64±11</td>
<td>63-216 145±37 38-91 67±12</td>
</tr>
<tr>
<td>4.</td>
<td>10</td>
<td>169-259 221±26 14-49 35±10 8-21 16±4</td>
<td>149-214 186±21 79±92 84±5</td>
<td>149-214 186±21 79±92 84±5</td>
<td>149-214 186±21 79±92 84±5</td>
<td>149-214</td>
</tr>
<tr>
<td>Whites</td>
<td></td>
<td>175-289 218±36 25-58 36±11 9-26 17±5</td>
<td>137-263 182±38 74-91 83±5</td>
<td>137-263 182±38 74-91 83±5</td>
<td>137-263 182±38 74-91 83±5</td>
<td>137-263</td>
</tr>
</tbody>
</table>

* The detailed statistical analysis has been omitted.
† Groups as in table 1.
‡ One subject (not classified) has been excluded from the analysis.
§ Two subjects, one of whom had diabetes mellitus, and one "vascular disease," have been excluded.
|| One subject in class 3 has been excluded.

It has been our experience that paper electrophoretograms on serum stored for longer than 24 hours at 4°C may show a slight decrease in ω-lipoprotein and a corresponding increase in β-lipoprotein.

RESULTS

The various groups into which the subjects have been divided are shown in table 1, and each group has been further classified according to the serum total lipid and total cholesterol concentrations. Class 1 includes all the subjects whose total lipids were below 700 mg. per cent and whose cholesterol concentrations were below Keys' upper limit for 90 per cent of an American population of the same ages. These upper limits ranged from 219 mg. per cent at 18 years to a maximum of 332 mg. per cent at 55 years, and thereafter a gradual decrease to 276 mg. per cent at 75 years of age. Cholesterol levels reported for white South Africans and our own unpub-
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Table 3.—Serum Total Lipids and Lipoprotein Fractions in "Normcholesteremic" Bantu and White Men (Classes 1 and 2)*

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of subjects</th>
<th>Total lipids mg per 100 ml.</th>
<th>(\alpha)-Lipoprotein % Total lipids</th>
<th>(\beta)-Lipoprotein % Total lipids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Mean ± S.D.</td>
<td>Range</td>
</tr>
<tr>
<td>Bantu</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>38‡</td>
<td>310–780</td>
<td>461±97</td>
<td>0–54</td>
</tr>
<tr>
<td>2.</td>
<td>6</td>
<td>480–770</td>
<td>600±34</td>
<td>22–55</td>
</tr>
<tr>
<td>3.</td>
<td>20§</td>
<td>490–760</td>
<td>617±75</td>
<td>0–52</td>
</tr>
<tr>
<td>4.</td>
<td>10</td>
<td>433–750</td>
<td>567±98</td>
<td>12–32</td>
</tr>
<tr>
<td>Whites</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>14</td>
<td></td>
<td></td>
<td>470–980</td>
</tr>
<tr>
<td>6.</td>
<td>12</td>
<td>473–820</td>
<td>612±90</td>
<td>6–26</td>
</tr>
</tbody>
</table>

* The detailed statistical analysis has been omitted.
† Groups as in table 1.
‡ One subject (not classified) has been excluded from the analysis.
§ Two subjects, one of whom had diabetes mellitus, and one "vascular disease," have been excluded.
|| One subject in class 3 has been excluded.

lished figures are of the same order. Class 2 includes all subjects whose total lipids were above 700 mg per cent but whose cholesterol levels were below the same upper limits as class 1. Class 3 includes all subjects showing total lipids above 700 mg per cent and total cholesterol values above Keys' upper limits.

It will be seen from table 1 that only 2 of the young Bantus and only 4 of the older Bantu fell into class 2, and none into class 3, although 1 individual had a raised serum cholesterol while the total lipid concentrations were normal. The white men showed a similar class distribution. In order to determine whether differences existed in "normcholesteremic" subjects a statistical analysis of the data in classes 1 and 2 was carried out. The results are presented in tables 2 and 3, and the more important conclusions follow.

**Total Cholesterol and Lipoprotein Cholesterol Fractions (Table 2).** The old urban Bantu group shows similar levels of total cholesterol to the "normal" white group (\(p=0.5\)) and to the white group with non-vascular organic disease (\(p=0.8\)). This lack of difference is surprising in view of previous reports 2,4 and is probably related to the higher standard of living of the old urban Bantu group in this study. This interpretation is supported by the fact that the convalescent Bantu group, which consisted of individuals in poorer economic circumstances, show significantly lower (\(p<0.01\)) total cholesterol levels than both old urban Bantu and white subjects, and similar levels to the young urban Bantu. Considerable differences are, however, apparent in the cholesterol fractions. There is a highly significant decrease (\(p<0.01\)) in the mean \(\alpha\)-lipoprotein cholesterol percentages and absolute values in both white groups when compared to the old urban Bantu, and also a highly significant increase (\(p<0.01\)) in the \(\beta\)-lipoprotein-cholesterol percentages and absolute values. In contrast the 2 white groups show no differences in either the percentages (\(p=0.6\)) or the absolute values (\(p=0.8\)) of the cholesterol fractions. The fact that these differences cancel out in the total cholesterol detracts considerably from the value of estimating the total cholesterol alone.

As for the young Bantus, both the rural and urban groups show significantly lower (\(p<0.01\)) mean total cholesterol concentrations than the old urban Bantu. The young rural group, however, shows both significantly lower (\(p<0.01\)) \(\alpha\)- and \(\beta\)-cholesterol concentrations, whereas the young urban group has
similar \( \alpha \)-cholesterols \((p=0.3)\) but lower \( \beta \)-cholesterol concentrations \((p<0.05)\). It is thus apparent that the rise in total cholesterol with age and improved living conditions in the urban Bantu is due to an increase in the \( \beta \)-fraction, whereas the rise from the young rural to the young urban Bantus is due solely to an increase in the \( \alpha \)-fraction \((p<0.01)\). It is noteworthy that there is no absolute increase in the \( \beta \)-cholesterol fraction from the rural to the young urban Bantus, the higher mean \( \beta \)-cholesterol percentage of the young rural men being simply a reflection of the lower \( \alpha \)-cholesterol concentration.

The \( \alpha \)-cholesterol fraction appears to reach an apparent maximum at 60 to 70 mg. per cent in the urban Bantu groups. The minimum \( \beta \)-cholesterol is found in the young urban or rural Bantu—approximately 110 to 115 mg. per cent. It is suggested below that these levels are optimal and on the basis of these figures it would follow that the "optimal" levels for the total cholesterol should be 170 to 185 mg. per cent, for the \( \alpha \)-lipoprotein cholesterol percentage 35 to 38 per cent, and for the \( \beta \)-lipoprotein cholesterol percentage 62 to 65 per cent. It is of significance that the percentage and absolute concentrations of \( \alpha \)- and \( \beta \)-lipoproteins published for young adult normal white women,\textsuperscript{22} confirmed in our laboratory (unpublished findings), agree with these values. Older white women also show significantly lower \( \alpha \)-cholesterol percentages and significantly higher \( \beta \)-cholesterol percentages than the old urban Bantus, and this also holds for the absolute concentrations of the \( \alpha \)-cholesterol and \( \beta \)-cholesterol fractions. Similar differences are found between old and young adult white women.

Total Lipids and Lipoprotein Fractions (Table 3). The lower total cholesterol concentrations of the young rural Bantus are paralleled by their significantly lower \((p<0.01)\) total lipid levels compared to both young and old urban Bantus. This again appears to be due mainly to the low \( \alpha \)-lipoprotein level in the young rural Bantus, which results in a lower \( \alpha \)-lipoprotein percentage, and is reflected in a higher \( \beta \)-lipoprotein percentage. Despite the apparent differences in the percentages of the 2 lipoprotein fractions the \( \beta \)-lipoprotein levels do not differ in young rural and urban Bantus. The young urban Bantu, however, show both a higher mean \( \alpha \)-lipoprotein percentage and a lower mean \( \beta \)-lipoprotein percentage than the old urban Bantu although the total lipid levels of the 2 groups are not significantly different \((p=0.4)\). Similar conclusions are reached when the young Bantus are compared with the older convalescent Bantu group. Analysis of the lipid and lipoprotein fractions, therefore, confirm the cholesterol findings but the results are in general of lesser significance in view of the greater scatter of the lipoprotein values. This scatter is thought to be due to the inherently greater error in the estimation of the stained lipoprotein bands as compared to the measurement of the cholesterol fractions.\textsuperscript{12}

**Discussion**

It is now generally accepted in American and western European countries that apparently healthy people do not necessarily represent normality, i.e., freedom from atherosclerosis, since myocardial infarction is endemic in these countries. This also appears to be true for white South Africans, whereas the South African Bantu is not so severely afflicted with atherosclerosis.\textsuperscript{8} These features have been correlated with the lower cholesterol levels in the Bantu and more recently\textsuperscript{7} with lower \( S_r \) 12-20 and \( S_r \) 20-100 classes of the \( \beta \)-lipoproteins of the Bantu when compared with the "normal" levels for a sample of the New York City white population. No comparable ultracentrifuge studies have yet been reported for normal white South Africans, but the differences in the low density bands of lipoproteins between the Bantu and American groups are supported in the present investigation by the demonstration of significant differences between the \( \alpha \) and \( \beta \)-lipoprotein cholesterol of the Bantu and South African white subjects.

The implications of the differences in the cholesterol fractions between the Bantu and
white groups may be of considerable significance. It is apparent from what has already been said that the "normal" values for cholesterol in countries where atherosclerosis is endemic may be far above the "ideal" value, which could be defined as the cholesterol level in individuals free of atherosclerotic lesions. This of course assumes the validity of the premise that an etiologic relationship exists between cholesterol concentration and atherosclerosis. The substitution of an ideal value for an indefinable "normal" range has much to commend it. The "ideal" serum cholesterol would in practice simply mean the mean value found in communities where a "successful modern civilization" has not been established, and where presumably there is a low incidence of atherosclerosis, and certainly a low incidence of coronary thrombosis.

It has been claimed that a strong argument can be developed for the contention that the ideal serum cholesterol level for an adult human being is about 150 mg. per cent. Such levels have been found in several primitive communities. In this study the mean cholesterol level of the group of rural young Bantu, 145 ± 38 mg. per cent, would appear to support this claim, but an examination of the α- and β-lipoprotein cholesterol levels of young rural and urban Bantus reveals the fact that while no difference exists between the mean levels of β-lipoprotein cholesterol, the former show considerably lower α-lipoprotein cholesterol levels. There is also a lower α-lipoprotein percentage in the rural Bantu, which confirms a previous study in Nigeria. It is remarkable that the low α-lipoprotein level of the rural Bantu studied here and of the African peasants studied in Nigeria is simply an expression of the poor physical state and low-fat intake of these people. With "improved" development the first striking change seen in the young urbanized Bantu is an increase of the α-fraction, which approximately doubles itself and remains at this level in the older groups. Similar α- and β-cholesterol levels have been found in our laboratory for young healthy white women, and we have come to regard the "ideal" value for the total cholesterol as being in the region of 170 to 180 mg. per cent, rather than in the region of 150 mg. per cent, which is the level found in malnourished primitive communities.

Judged by these criteria, all the normocholesteremic white subjects in this study may be considered abnormal. This conclusion is supported by the high incidence of atherosclerosis, despite apparent good health, of the South African white population.

These findings have prompted us to consider the advisability of determining the "ideal" values for both α- and β-cholesterol separately. This would be a logical attempt to extend into the biological field the established physicochemical differences between the α- and β-lipoprotein cholesterol fractions. As a working hypothesis we have regarded the α-lipoprotein component as being better adapted to the "physiologic" transport of fatty acids than the β-lipoprotein. This view is supported by the higher concentrations of this component in human subjects relatively free of atherosclerosis and in those animal species resistant to experimental atherosclerosis, and also by the association of the heparin-clearing factor with α-lipoprotein, although this finding has been challenged. The evidence indicating the "pathologic" background of high levels of β-lipoprotein cholesterol is also well known. If this hypothesis is valid, it follows that racial groups with a low incidence of atherosclerosis and coronary thrombosis have "ideal" levels of α- and β-lipoprotein cholesterol. We consider that the ideal values for α-lipoprotein cholesterol should be 60 to 70 mg. per cent and for β-lipoprotein cholesterol 110 to 120 mg. per cent. A decrease in the α-level combined with an increase in the β-level would favor the development of pathologic arterial changes. However, the apparent paradox of a low α-level in a population group with a low incidence of atherosclerosis would be easily resolved by reference to the level of the β-lipoprotein cholesterol. Where this is at the "ideal" level, it would implicate some
factor other than arterial disease as responsible for the low α-level. Among impoverished African peasants, such an abnormality in fat transport could be due to poor nutrition, which would adequately explain the very low total cholesterol values, e.g., less than 100 mg. percent not infrequently encountered in these peoples.

Finally this hypothesis and the concept of "ideal" values for both α- and β-cholesterol may help in assessing the therapeutic significance of some of the measures proposed for the treatment of atherosclerosis. For example, although low-fat diets in atherosclerotic subjects decrease the total cholesterol and total lipid levels, they do not alter the α-lipoprotein cholesterol fractions, which remain obstinately below the "ideal" value. This finding suggests that such treatment has no effect on the metabolic abnormality that may underlie the atherosclerotic process. Estrogens on the other hand have been found to correct the pathologic protein-lipid relationships of survivors of myocardial infarction, producing an increase in the α-lipoprotein component and a decrease in the β-component. It is tempting to correlate this effect of estrogens with the normal lipoprotein pattern of the Bantu, since there is evidence of a different estrogen excretion pattern in these people.

While treatment with potent estrogens is for obvious reasons not desirable, therapeutic trials with similar compounds showing poor estrogenic activity should be conducted to assess the power of such compounds to alter the lipoproteins to the ideal pattern.

**Summary**

Both the rural and urban young Bantu groups show significantly lower total cholesterol concentrations compared to the old urban Bantu. The young rural group, however, shows both significantly lower α- and β-cholesterol, whereas the young urban group has similar α-cholesterol but significantly lower β-cholesterol. The increase of total cholesterol with age in the Bantu is thus almost entirely due to increase in the β-fraction, whereas the increase from the young rural to the young urban subjects is due to a significant increase in the α-fraction. It is noteworthy that there is no increase in the β-cholesterol fraction from the young rural to the young urban Bantu.

The mean cholesterol concentrations of old urban Bantu and whites of comparable ages are similar, but the old Bantus show significantly higher α-cholesterol and significantly lower β-cholesterol than the whites. These 2 differences appear to cancel out in the total cholesterol and this fact detracts considerably from the value of this estimation.

The lower total cholesterol concentrations of the rural Bantu are paralleled by their significantly lower total lipid levels, and again this is due mainly to the low α-lipoprotein concentration. The contrast between the lipoprotein fractions of Bantu and whites is similar to the cholesterol patterns, but the results are of less significance in view of the greater scatter of the lipoprotein results.

The findings reported in this paper have prompted us to consider the advisability of determining the "ideal" values for both α- and β-cholesterol separately. This would be a logical attempt to extend into the biological field the established physicochemical differences between the α- and β-lipoprotein cholesterol fractions. Our results suggest that ideal values for α-lipoprotein cholesterol are 60 to 70 mg. per cent and for β-lipoprotein cholesterol 110 to 120 mg. per cent. A decrease in the α-level combined with an increase in the β-level is considered to favor the development of atherosclerosis.

**Acknowledgment**

Our thanks are due to the Medical Superintendents and Staffs of the Witwatersrand Native Labour Association and Coronation Hospitals, Dr. N. J. Pretorius, Medical Director of Public Utility Transport Corporation, and our many clinical colleagues in Johannesburg for allowing us access to cases under their care, and for their unfailing courtesy and cooperation during the course of this study.

**Summario in Interlingua**

Le gruppos de juvenile bantus, tanto rural como etiam urban, monstra concentrationes...
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de cholesterol total significativamente plus basso que le gruppo de bantus urban de etates plus avvantiate. Tamen, le juveme gruppo rural mostra valors significativamente plus basso tanto pro cholesterol alpha como etiam pro cholesterol beta, durante que le juveme gruppo urban ha simile valors pro cholesterol alpha sed significativamente plus basso valors pro cholesterol beta. Assi le augmento del cholesterol total occurrente in le bantus con le progresso de lor etate es quasi integrame attituable a un augmento del fraction beta, durante que le differentia inter le juveme gruppos rural e urban es attribuire a significativemente altiate valores del fraction alpha in le gruppo urban. Il merita esser notate que le valors de cholesterol beta non es significativamente plus alte in le juveme bantus urban que in le juveme bantus rural.

Le concentrationes medie de cholesterol in bantus urban de etate plus avvantiate es simile a illos in blancos de etate comparabile, sed le bantus de etate plus avvantiate mostra significativamente plus alte concentrationes de cholesterol alpha e significativamente plus basso concentrationes de cholesterol beta que le subjectos blanco. Iste 2 differentia se cancella apparentemente in le cholesterol total—un facto que reduce consideramebilemente le utillate de iste estimation.

Le plus basse concentrationes de cholesterol total in le bantus rural es parallel a lor significativamente plus basse nivellos de lipido total, e isto es de novo attribuire principalemente al basse concentration de lipoproteina alpha. Le differentia inter le fractiones lipoproteine in bantus e in blancos es simile al differentia in le valors pro cholesterol, sed le resultatos in le caso de lipoproteina es minus significative a causa de un plus extens dispersion del valors.

Le constatationes reportate in le presente studio ha inducere nos a considerar le utillate de determinar valors "ideal" separatemente pro cholesterol alpha e cholesterol beta. Isto esserea un essayo logic de transferer ab le campo physico-chimic a in le campo biologie le establite differentias inter le fractiones de cholesterol a lipoproteina alpha e beta. Nostre resultatos suggere que valors ideal pro cholesterol a lipoproteina alpha es inter 60 e 70 mg pro cento e pro cholesterol a lipoproteina beta inter 110 e 120 mg pro cento. Un reduction del fraction alpha combinate con un augmento del fraction beta es considerate como un factor favorabile al disveloppamento de atherosclerosis.

REFERENCES
11. PEARSON, S., STERN, S., AND McGAVACK, T.


When first I applied my mind to observation from the many dissections of Living Creatures as they came to hand, that by that means I might find out the use of the motion of the Heart and things conduceable in Creatures; I straightways found it a thing hard to be attained, and full of difficulty, so with Faestorius I did almost believe, that the motion of the Heart was known to God alone.—William Harvey. De Motu Cordis, 1628.
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