Body Build and Plasma Lipid Level

KAORU OYAMA*, HARUO UZAWA**, MASAKI MATSUDA*  
AND KUNITARO IMAICHI***

* Toyama Prefectural Central Hospital, Toyama  
** The 2nd Medical Division, Department of Internal Medicine, Kyushu University, Fukuoka  
*** Fujikoshi Hospital, Toyama

Plasma lipid level and body build have been discussed repeatedly in relation to atherogenesis. Known studies leave little doubt that atherosclerotic disease is more common in obese subject and most cases of coronary heart disease are associated with elevated plasma lipid levels. There have been, however, different opinions on the relation between bulkiness or adiposity and plasma lipid levels. In the present study, plasma lipid levels of 195 males between 45 and 55 years of age and were uniform in all respects were examined. The results were statistically analyzed in relation to bulkiness of the body as expressed by relative weight.

The relationship between plasma lipid level, body build and atherosclerotic heart disease have been repeatedly discussed by numerous investigators. So far as we understand, atherosclerosis is more common in those who are obese or are overweight at all ages, of both sexes, and most cases of coronary heart disease are associated with elevated plasma lipid levels. Elevation of plasma lipid level is considered to predispose to atherogenesis, though there are different opinions in the evaluation of elevated plasma lipid level as a factor producing atherosclerotic disease.

On the relation between body build and plasma lipid level, previous reports have not always been in agreement. There are several reports which indicate that excess bulk or adiposity is associated with elevation of plasma cholesterol level. Contrarily some investigators indicated that there was no significant relationship between plasma cholesterol level and the bulkiness or adiposity of the body. More recently the effect mortality from atherosclerotic heart disease has shifted some emphasis to the importance of triglyceride or of free fatty acid.

In our previous study, plasma lipid levels of several hundreds males were examined for an analysis of the effect of various types of diet on the plasma lipid levels. Among the cases studied, 195 were workers at the same machine factory and were living in the same city with similar level of income and living conditions. They ranged in age between 45 and 55, and were working in healthy conditions without any notable presence of disease.

This paper describes the results of statistical analysis on the relation between the body build expressed by relative weight and plasma lipid level in the above 195 cases. As the samples in this study were quite uniform in all respects and the sample number was large enough, we believe the results have a value to be added to the accumulation of information obtained from previous studies.

Materials and Methods

The background of the cases examined is described above. All subjects were well tolerating moderate labor under healthy conditions. They had body builds within the range of normality and there were no cases of abnormal obesity.

Experimental procedures were as follows;
1) Blood specimens were taken after overnight fast with vacutainer, then plasma was separated by centrifugation.
2) 4ml of plasma was made up to 100ml of
methanol-acetone filtrate (1:1).
3) Total cholesterol values were determined by a
modification of Schoenheimer-Serry’s method.10)
4) Phospholipid value by Youngberg-Young-berg’s method.10)
5) Glyceride value by Michaels’ method.17)
6) Calculations for statistical analysis were per-formed using an electronic computer because of the
large sample number.

RESULTS
Relation between Weight and Height
Whyte10) mentioned that weight (W) varied
with the squares of the height (H) as a general
rule and regarded W/H² as an index of the
bulkiness of the body. We calculated both linear
and curvilinear regressions of weight on height
by the method of least squares for the 195 cases
and obtained the following equations:
\[
W (\text{kg}) = -66.698 + 0.757H (\text{cm})
\]
\[
W (\text{kg}) = -85.312 + 0.988H (\text{cm})
\]
\[-0.0007H² (\text{cm})\]
As shown in Fig. 1, those two equations were
very close and weight varied practically in pro-
portion to height, at least in subjects examined
in this study. Therefore we used values obtained
from the linear regression equation as a standard
weight (W*) in this study. Then we settled the
value of \(W - W^*/W^* \times 100\) as an index of the
bulkiness of the body.
Correlation between Relative Weight and
Plasma Lipid Levels
There is no proof that there is a linear cor-
relation between bulkiness or adiposity of the
body and plasma lipid levels even if there exists
some relation. We feel curvilinear correlation is
more likely to exist, considering from several
types of biological effect in the field of lipids.
We calculated, however, linear regressions of
plasma lipid levels on the index of bulkiness
\((W - W^*/W^* \times 100)\) for simplicity to observe
whether there existed significant correlations
between these two factors. Fig. 2, 3 and 4 are
scatterdiagrams demonstrating the relation be-
tween the three plasma lipid levels and the in-
dex of bulkiness. Regression equations obtained
were as follows:

\[
W = -66.698 + 0.757H
\]
\[
W = -85.312 + 0.988H - 0.0007H²
\]

Fig. 1. Weight and height.
Ch (mg%) = 0.40m + 158.41 mg%  
Ph (mg%) = 0.31m + 182.40 mg%  

G (mg%) = 0.56m + 77.98 mg%  
Ch = Total cholesterol (mg%)  

Fig. 2. Plasma total cholesterol and relative weight.

Fig. 3. Plasma phospholipid and relative weight.

*Japanese Circulation Journal* Vol. 29, October 1965
Ph = Phospholipid (mg%)
G = Glyceride (mg%)
m = W - W*/W* × 100

Values of the three plasma lipids were all directly correlated with the index of bulkiness. According to the equations, 20% of overweight resulted in rises of 8.0 mg% of total cholesterol, 6.2 mg% of phospholipid and 11.2 mg% of glyceride statistically. Test results of the above correlations were as follows:

\[ r \quad t \quad t(0.005) \quad t(0.05) \]

<table>
<thead>
<tr>
<th></th>
<th>( r )</th>
<th>( t )</th>
<th>( t(0.005) )</th>
<th>( t(0.05) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol</td>
<td>0.212</td>
<td>3.01**</td>
<td>2.81</td>
<td>1.96</td>
</tr>
<tr>
<td>Phospholipid</td>
<td>0.154</td>
<td>2.16**</td>
<td>2.81</td>
<td>1.96</td>
</tr>
<tr>
<td>Glyceride</td>
<td>0.231</td>
<td>3.29**</td>
<td>2.81</td>
<td>1.96</td>
</tr>
</tbody>
</table>

The correlation coefficients were relatively small. However, the test results revealed that the correlations between the index and total cholesterol and glyceride were both highly significant (\( p < 0.005 \)), and that between the index and phospholipid was also significant (\( p < 0.05 \)).

**DISCUSSION**

It is difficult to measure the true degree of adiposity, though several types of procedures have been described. Relative weight is the simplest measure to presume the bulkiness of the body. Whyte\(^6\) mentioned that relative weight, using \( W/H^2 \) as an index, was closely correlated with the degree of adiposity measured by skinfold thickness. We found that there was a practically linear correlation between weight and height in the limited subject group in this study. Montoye\(^8\) also mentioned that the squares contributed only a minimal reduction in variance after an examination of the curvilinearity of the regression of the skeletal measurements on weight.

There have been several reports on the relation between the bulkiness or adiposity of the body and plasma cholesterol level. Tanner\(^7\), Lawry and coworkers\(^2\), Hobson and coworkers\(^9\) mentioned that there existed significant correlations. On the other hand, Whyte\(^5\), Spain and coworkers\(^9\), Goldbrick\(^7\), Thomas and Garn\(^9\) mentioned that the correlation was not signifi-
sufficient enough and hypercholesterolemia could not be invoked to help explain the liability of the obese to coronary heart disease. The results of our statistical analysis showed that there were direct correlations between relative weight and plasma total cholesterol, phospholipid and glyceride levels. The correlation coefficients were relatively small, but test results revealed that the correlations between relative weight and total cholesterol and glyceride were highly significant, and that between relative weight and phospholipid was also significant. Plasma glyceride value to which importance has been attached more recently was the most closely associated with the bulkiness of the body among the three plasma lipids.

It is still questionable whether the elevation of plasma lipid level is a direct factor producing atherosclerotic heart disease or the elevated plasma lipid level is one of the phenomena in the condition which promotes the development of atherosclerosis. We feel the elevation of plasma cholesterol level resulting from various causes is at least one of the major factors in the development of atherosclerosis. Life insurance statisticians tell us the presence of obesity increases the tendency to the clinical complications of cardiovascular disease. The frequency of coronary heart disease has been considerably lower in Japan that in the United States, Europe and Australia. According to Switzer, there is a marked difference in plasma total cholesterol level between Japan and the United States (averaging 148 mg\% against 225 mg\%). Keys 12 mentioned that the difference in the frequency of coronary heart disease between Japan and the United States was due to the difference in dietary habits rather than the racial difference. The contribution of a relatively low caloric diet, low fat intake and high fish consumption to the lower plasma lipid is evident from our previous study 14. From the results of this study, lesser bulkiness of the body seems to be another major factor of lower plasma lipid level in Japan. The body build of the average Japanese is steadily getting bulkier as diet changes in the direction of higher intake of more calories and more fat. Thus the increase in the frequency of coronary heart disease seems to be inevitable unless proper regimens are considered.

SUMMARY

Plasma lipid levels of 195 males who were quite uniform in all respects were examined and we observed significant correlations between relative weight and plasma lipid levels.

ACKNOWLEDGMENT

We wish to express our appreciation for the determination of plasma lipids to Dr. Lawrence W. Kinsell and his staff, Institute for Metabolic Research, Highland-Alameda County Hospital, California. We are grateful to Mr. Robert E. Keys for permitting us to read an article in advance of publication.

REFERENCES


Japanese Circulation Journal Vol. 29, October 1965
15) Schoenheimer, R., and Sperry, W. M., A Micro-
method for the Determination of Free and Com-
16) Youngberg, G. E. and Youngberg, M. V., Phos-
phorus Metabolism. 1. A System of Blood Phos-
17) Michaels, G., A Method for the Determination of
Plasma Glycerides and Free Fatty Acids. Metabo-

18) Montoye, H. J. et al., The Measurement of Body
19) Society of Actuaries., Build and Blood Pressure
20) Switzer, S., Hypertension in Japan. Medicine et
Hygiene 630; 186, 1964.
21) Keys, A. et al., Lessons from Serum Cholesterol