Prevalence of Cardiovascular Diseases in the Kingdom of Tonga

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SUMMARY

The blood pressure, electrocardiographic findings and serum total cholesterol of Tongans, characterized by extreme obesity, were compared with those of Japanese employees of a trading firm in Tokyo. The prevalence of cardiovascular diseases in Tongans as far as assessed by these measurements was rather low for their excessive obesity. It is unclear whether the relatively low prevalence rate of cardiovascular diseases among the Tongans is due to genetic factors which might be considered an ethnological difference, or to environmental factors. Reducing weight is very difficult for many obese people. Accordingly, if "healthy obesity" exists, elucidation of its mechanism will be glad tidings for obese persons. However, the most prevalent diseases among the Tongans were the same as those of the developing countries. Consequently, imitating the Tongan lifestyle does not necessarily assure the longevity of obese persons of developed nations, although it may decrease the risk of the cardiovascular diseases.

Additional Indexing Words:
Obesity Hypertension Tonga ECG abnormality

The authors have performed two mediconutritional surveys since 1977 in the Kingdom of Tonga, located in the South Pacific Ocean, reporting that the Tongans are characterized by "healthy obesity" which differs from the obesity found in advanced nations.1) We wanted to try to clarify the true nature of this "healthy obesity" and performed the present, third, survey (November 1983), focusing on cardiovascular diseases. We compared the prevalence of cardiovascular diseases among the Tongans with that in Japanese people, especially in terms of its relation to obesity.
SUBJECTS AND METHODS

The Tongan subjects, randomized from all areas of the Kingdom of Tonga, were 305 adults ranging in age from 21 to 91 years. All of the subjects were typical Tongans with traditional lifestyle and customs. In this South Pacific country, as a rule one needs a license to drink alcohol, but smoking is unrestricted. Among the subjects, 102 males ranging in age from 35 to 79 years (52.7±11.4 years, mean±SD) were subjected to analysis because their data were considered complete. None of them were receiving any medication. Japanese subject data were obtained from a medical check for geriatric diseases in a trading firm in Tokyo carried out in July, 1983. There were 510 male participants ranging in age from 35 to 76 years (mean 46.6±6.0 years) and the participation rate was 92%. In order to compare efficiently the data with those of the Tongans, we adjusted the ages and used the data of those Japanese over 45 years old (mean 53.2±6.1 years, n=280). For the electrocardiographic (ECG) data, however, only subjects over 49 years old (mean 55.6±5.9, n=195) were used, because ECG records were available for only 74 Tongans (age range 35–79, mean 56.4±10.0). Procedures for the medical check in the Tongans and Japanese were as follows: Right arm blood pressure with the subject in the sitting position was measured after 5 min rest by doctors using a mercurial sphygmomanometer, with a cuff 13 cm wide and 24 cm long for the Japanese subjects and for most of the Tongans. A 16×40 cm cuff was used to measure the blood pressure of 21 Tongan subjects weighing over 100 kg. Fasting blood samples were obtained for enzymatic measurement of serum total cholesterol. A standard 12-lead resting ECG was taken and was interpreted according to the Minnesota code (1968). The degree of obesity was calculated as follows: body weight×[(body height –100)×0.9]×100.

In addition, the findings were compared with the results of the National Survey on Circulatory Disorders (conducted in November, 1980, in Japan) for reference. This survey included 4,795 males over 30 years of age (mean 50.8±13.1 years). Statistical analysis was done by Student’s t-test, analysis of variance and χ²-test.

RESULTS

Table I shows mean age, body height, body weight, degree of obesity, serum total cholesterol, systolic blood pressure, diastolic blood pressure and skin folds (upper arm+back) in the 3 groups. The Tongans were much more obese than the subjects in the 2 Japanese groups but the diastolic blood
Systolic blood pressure of the Tongans was lower. Systolic blood pressure of the Tongans was higher than that of Japanese clerks although it was lower than the systolic blood pressure of the Japanese in the national survey. The number of subjects whose diastolic blood pressure was over 95 mmHg was 6 (6%) in the Tongans and 30 (11%) in the Japanese clerks. Adding 7 patients who were receiving antihypertensive medication and whose diastolic blood pressure was below 95 mmHg, the percentage of hypertension (diastolic blood pressure ≥95 mmHg and/or under antihypertensive medication) in the Japanese clerks was 13%, which was significantly higher than the prevalence of hypertension among the Tongans (χ²-test, p<0.05). The number of systolic hypertensive subjects (systolic blood pressure ≥160 mmHg and/or under antihypertensive medication) was 4 (4%) in the Tongan group and 18 (6%) in the Japanese clerks, with the difference not being statistically significant. Among the Tongans and the Japanese clerks the degree of obesity correlated significantly with the diastolic blood pressure (correlation coefficients, r=0.20, p<0.05, Fig. 1, and r=0.22, p<0.01, respectively). It also correlated positively with systolic blood pressure but this was not statistically significant in the Tongans (r=0.19, p<0.10). In the Japanese clerks, the correlation coefficient between the degree of obesity and systolic blood pressure was r=0.22 (p<0.01). Systolic and diastolic blood pressure and serum total cholesterol were significantly correlated with the skin folds in the Tongans, the correlation coefficients being r=0.20 (p<0.05), r=0.40 (p<0.01) and r=0.37 (p<0.01), respectively. The serum total cholesterol was not significantly correlated with the degree of obesity in the Tongans (r=0.18, p<0.10), but in the case of Japanese clerks, the correlation was significant (r=0.22, p<0.01).

Table II shows the prevalence of ECG abnormality in the Tongans and
Fig. 1. Correlation between the degree of obesity and diastolic blood pressure in the Tongans.

Table II. Comparison of ECG Findings between the Tongans and the Japanese (number and percentage)

<table>
<thead>
<tr>
<th></th>
<th>Tongans (n=74)</th>
<th>Japanese clerks (n=195)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>56.4±10.0</td>
<td>55.6±5.9</td>
</tr>
<tr>
<td><strong>Incomplete right bundle branch block</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete right bundle branch block</td>
<td>17 (23%)</td>
<td>17 (23%)</td>
</tr>
<tr>
<td></td>
<td>0 ( 0%)</td>
<td>11 (6%)</td>
</tr>
<tr>
<td><strong>Left ventricular hypertrophy</strong></td>
<td>4 ( 5%)</td>
<td>41 (21%)*</td>
</tr>
<tr>
<td><strong>Atrial premature beats</strong></td>
<td>2 ( 3%)</td>
<td>1 ( 1%)</td>
</tr>
<tr>
<td>Ventricular premature beats</td>
<td>5 ( 7%)</td>
<td>7 ( 9%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 ( 1%)</td>
</tr>
<tr>
<td><strong>Atrial fibrillation</strong></td>
<td>2 ( 3%)</td>
<td>3 ( 2%)</td>
</tr>
<tr>
<td><strong>ST-T changes</strong></td>
<td>13 (18%)</td>
<td>54 (28%)</td>
</tr>
<tr>
<td>1st degree AV block</td>
<td>5 ( 7%)</td>
<td>5 ( 3%)</td>
</tr>
</tbody>
</table>

* Significantly different from Tongans ($\chi^2$-test, $p<0.05$).

the Japanese clerks. Incomplete right bundle branch block (iRBBB) was more frequently seen in the Tongans than in the Japanese clerks, while the frequency of complete right bundle branch block was the reverse. The summed frequency of right bundle branch block was higher in the Tongans.
Left ventricular hypertrophy was more frequent among the Japanese clerks as expected and premature beats were more frequent in the Tongans. The frequencies of the other findings were almost the same in both groups.

**Discussion**

Cardiovascular diseases are related to the degree of overweight differently depending on race or country. However, many transectional studies in a single population have shown that the overweight individuals had higher blood pressure and this was seen in both advanced nations and developing countries. In contrast to this, there are many reports that the positive correlation between salt intake and blood pressure could not be seen in a single population. However, more hypertensive subjects are found in the high salt-consuming areas. In general, it is appreciated that the frequency of obesity, no matter what definition of obesity is used, is higher in advanced nations than in developing countries. Therefore, in advanced nations where the inhabitants are more obese, higher blood pressure levels are seen, although there are many exceptions. From the above-mentioned subjects, we are of the opinion that obesity has a more direct relation to hypertension than does sodium as Dustan stated. Weinsier et al, however, stated that the correlation coefficient between the indices of obesity and blood pressure is small, although statistically significant, and that the contribution of obesity to hypertension is minimal. Considering that the etiology of essential hypertension is thought to be multifactorial as in Page’s mosaic theory, and that blood pressure varies greatly with the condition of measurement, we thought it significant that many population studies and controlled studies show a close relationship between the indices of obesity and blood pressure. At least, it is an unlikely proposition that the relationship between obesity and hypertension is weak because of its low correlation coefficient.

In the Kingdom of Tonga, which is a developing country, the natives are characterized as excessively obese and as consuming a relatively low salt diet. In our former survey in 1976, the daily output of urinary sodium and potassium of the adult male Tongans (n=5, mean age 35.2±5.4 years) was 123 ± 71 mEq/day and 70±27 mEq/day, respectively. Among the Tongans, a positive correlation between the degree of obesity and blood pressure was noticed, as has been seen in the Japanese and other populations, and a significant correlation was also seen between age and blood pressure (Table III).

Compared with that of the Japanese, Tongan diastolic blood pressure was considerably lower in spite of their obesity although the systolic blood pressure was higher than that of the Japanese clerks. The reason why the
Tongans' systolic blood pressure was higher is unclear. Antihypertensive medication taken by the Japanese clerks might have influenced the blood pressure level. Regardless of this, the diastolic blood pressure of the Tongans was considerably lower than that of the Japanese clerks. It should be clarified whether the relatively low incidence of hypertension among the Tongans is due to a difference in genetic factors including body composition or body fitness which many investigators believe to be important in the relationship between overweight and risk factors of cardiovascular diseases, or to a difference in environment as follows: Tongans have relatively low salt intake, different foods, less alcohol, no stress accompanying urban life or differences in climate. The serum total cholesterol was positively correlated with the degree of obesity and/or skin folds in both populations, although one of these was not statistically significant, and was relatively lower in the Tongans than in the Japanese clerks, but this difference was not significant. There are several studies reporting a significant correlation between the degree of obesity and serum total cholesterol. This relation may differ by the type of obesity or environment.

It is unclear why iRBBB is more frequent among the Tongans. There was no clear relationship between iRBBB and obesity in either Tongans or Japanese. Although the lower prevalence of left ventricular hypertrophy among the Tongans may be due to their lower diastolic blood pressure, the different degree of obesity in the two populations may be related to the different prevalence of this ECG finding. No significant difference in ST-T changes was seen between them. This may suggest that obesity per se does not become a coronary risk factor unlike the results of the Framingham heart study. On the whole, there was no great difference in ECG findings be-
between the 2 groups.

Although no data were obtained on fasting blood sugar levels in the Tongans, the incidence of diabetes among them was probably low as judged by a qualitative test for urine sugar. It has been suggested that, however, the incidence of diabetes among the Tongans has increased over the last several years due to rapid westernization. Is obesity, which is thought by many people to be harmful to the cardiovascular system, not a problem in some circumstances? Is racial difference or a difference in environment more important than obesity as a cardiovascular risk factor?

Although among the Tongans the degree of obesity was positively correlated with blood pressure and total cholesterol as in the Japanese clerks, we concluded that the Tongans are comparably healthy, in spite of their obesity, as far as can be assessed by the above-mentioned measurements. Reducing weight is very difficult for many obese people. Therefore, if "healthy obesity" exists, elucidation of its mechanism will be glad tidings for obese persons. But considering that the most prevalent diseases in the Tongans are those of the developing countries, i.e. infectious diseases, for obese persons in developed nations to imitate the Tongan lifestyle does not necessarily assure their longevity.

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References