*Symposium*

# Cardiovascular Risk Factors Emerging in Chinese Populations Undergoing Urbanization

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**In this assessment of cardiovascular risk factors, we examined the association between dietary habits and blood pressure (BP) according to the World Health Organization (WHO) CARDIAC Study protocols in three Chinese populations aged 47-57 in Guangzhou prefecture (GZ group; 141 males, 158 females), Guiyang prefecture (GY group; 101 males, 103 females) and Taiwan (TW group; 102 males, 98 females). The same survey was repeated 10 yr later in the GY group to follow-up the past trends (MONALISA study). The observed systolic BP (SBP), diastolic BP (DBP), and body mass index (BMI), as well as the rates of hypertension, obesity and antihypertensive medication use were significantly higher in both genders in the TW group compared to the groups GZ and GY. There was no significant difference in SBP or DBP in either gender between groups GZ and GY. Blood analyses revealed that the levels of serum total cholesterol (T-CHO), and HbA1c, and the rates of hypercholesterolemia and high HbA1c were significantly higher in both genders in the TW than in the GZ and GY groups. No significant difference among the populations was observed in 24-h urinary sodium or magnesium excretion in either gender. In the combined total populations of men and women, however, significant positive correlations were observed between BMI and each of SBP, DBP, T-CHO, and glycohemoglobin in both genders. A food frequency analysis revealed significantly greater meat consumption and significantly less tea consumption and vegetable intake in the TW than in the GY and GZ groups. Both SBP and DBP have increased significantly over the past 10 yr in the GY group in both genders, and T-CHO as well as the rate of hypercholesterolemia increased over the same period in both genders. In conclusion, cardiovascular risk factors leading to hypertension, such as obesity, hypercholesterolemia and diabetes mellitus, are emerging in urbanized Taiwan and developing Guiyang due to the loss of traditional dietary habits. (*Hypertens Res* 1999; 22: 209-215)**

***Key Words*: BMI, hypertension, Chinese, cardiovascular risk, HbA1c**

Hypertension is a serious public health problem in developed countries because of its high prevalence and the concomitant increase in the risk of cardiovascular and renal diseases (*1-4*).

Although many animal experiments point toward an important genetic contribution in the etiology of hypertension, the relative contributions of environmental and genetic factors in the etiology of hypertension in humans remain controversial. Several studies (*5, 6*) have documented marked differences in the prevalence of cardiovascular diseases (CVD) among various countries, races and regions throughout the world, and have shown that these differences are largely attributable to changing lifestyles (especially changes in traditional dietary habits) rather than genetic factors (*7*).

Environmental factors, such as dietary habits, are thought to play a significant role in the development of obesity and hypertension in many developing countries. In China, cardiovascular diseases, including hypertension and stroke, have been major causes of death over the past decade. According to World Health Organization (WHO) reports (*8, 9*), the improvement of dietary-related factors is critical to primary prevention of essential hypertension, atherosclerosis and coronary heart diseases.

In the present study, we evaluated the differences in the distribution of various risk factors of cardiovascular diseases among three middle-aged Chinese populations with different dietary habits: two Chinese populations residing in Guangzhou and Guiyang prefectures on the Chinese continent and a Chinese population on the island of Taiwan. We also examined trend in the change in cardiovascular risk factors in the Guiyang population over the past 10 yr.

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## Methods

The survey involved a total of 690 Chinese men and women aged 45-59 yr from two populations on, the continent of China (Guiyang and Guangzhou), and one population on the island of Taiwan. The participants were recruited randomly from lists of residents obtained through local governmental offices and medical universities (from Hwa Xi in Guiyang, Meizhou in Guangzhou, and Taibai in Taiwan). The Guangzhou (GZ) group consisted of 300, and the Guiyang (GY) group 190, and the Taiwan (TW) group 200 subjects.

Guangzhou prefecture faces the south Chinese sea. It includes continental plain and hilly districts, and is well-known for its light industrial and tea-producing districts. Guiyang is located in the southwest of the continental table and generally consists of agricultural countryside. Taibai, located in central Taiwan, is an industrialized city.

The present studies were conducted according to the protocol of the Cardiovascular and Alimentary Comparison (CARDIAC) study (*10*) coordinated by WHO. Blood pressure (BP) was measured three times in all subjects using an automated BP measurement system (*11, 12*), and the lowest value was used for the statistical analyses of blood pressure. The protocol consisted of a 24-h urine collection using an Aliquot Cup (*13, 14*), blood sampling after a 10-14 h fast and an interview based on standardized questionnaires with items on medical history, usual dietary habits including meat and vegetable intake frequency per wk and consumption of tea in the week before the study. Various biological markers of diets from urine and blood (urine: sodium, potassium, calcium, magnesium; blood: serum total cholesterol, high-density lipoprotein (HDL)-cholesterol, glycohemoglobin) were analyzed centrally at the WHO Collaborating Centre for Research on Primary Prevention of Cardiovascular Diseases, Graduate School of Human and Environmental Studies, Kyoto University, Kyoto, Japan. Standardized biological methods were used to analyze total cholesterol and HDL-cholesterol (enzymatic methods, Kit determiner TC555, Kyowa Medics, Tokyo), sodium, potassium (flame photometry), calcium (ion chromatometry), magnesium (atomic absorption, z-8000 Hitachi, Tokyo), and glycohemoglobin (high-performance liquid chromatography, HLC-723GHb, Toyosoda, Tokyo). The details of these analytical methods were described in our previous reports on the protocol and findings of the CARDIAC study (*10, 15-17*).

### *Statistics*

Statistical analyses were performed by analysis of variance (ANOVA) for the differences of means between three groups, and Scheffe's *F*-test was applied for differences between two populations among the three populations: The $\chi^2$ test and $\chi^2$ test for trends were used to compare proportion or prevalence. In addition, a multivariate analysis was performed by analysis of covariance (ANCOVA). A linear regression analysis was used to determine the significance of correlations between body mass index (BMI kg/m$^2$) and each of systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol, HDL-cholesterol, and glycohemoglobin.

Results from 9 men in the GZ group, 2 men and

**Table 1. Physical Characteristics of the Three Populations of Men and Women**

| Number in group | Guangzhou Group GZ | Guiyang Group GY | Taiwan Group TW | ANOVA or $\chi^2$-test | $\chi^2$-test for trend |
|---|---|---|---|---|---|
| M/W | 150/150 | 98/92 | 100/100 | | |
| Age (Yr) | | | | | |
| Men | 51.6±3.4 | 51.3±2.1 | 52.3±4.2 | NS | |
| Women | 51.9±3.1 | 51.7±3.3 | 51.7±5.2 | NS | |
| Height (mm) | | | | | |
| Men | 163.5±6.1 | 161.5±6.5 | 162.9±4.2 | NS | |
| Women | 155.7±5.6 | 152.1±6.3 | 154.8±5.2 | NS | |
| Weight (kg) | | | | | |
| Men | 55.2±9.8 | 56.9±9.8 | 59.6±8.2*,# | $p<0.01$ | |
| Women | 52.0±7.2 | 52.1±7.9 | 57.6±7.2*,# | $p<0.01$ | |
| BMI (kg/m$^2$) | | | | | |
| Men | 20.3±3.2 | 21.9±2.6 | 25.2±3.8**,## | $p<0.001$ | |
| Women | 20.6±2.6 | 22.5±3.0* | 25.0±3.4**,## | $p<0.001$ | |
| Obese (%) >26 (kg/m$^2$) | | | | | |
| Men | 3.4 | 10.2** | 35.2**,## | $p<0.001$ | $p<0.001$ |
| Women | 4.2 | 9.6** | 37.3**,## | $p<0.001$ | $p<0.001$ |

NS, not significant. *$p<0.01$, **$p<0.001$ *vs.* Group GZ; #$p<0.01$, ##$p<0.001$ *vs.* Group GY. Values are expressed as mean±SEM or prevalence. Group: GZ, Guangzhou; GY, Guiyang; TW, Taiwan. BMI, body mass index; NS, not significant.

**Table 2. Blood Pressure and Rate of Hypertension in the Three Populations of Men and Women**

| Number in group | Guangzhou | Guiyang | Taiwan | ANOVA or | $\chi^2$-test for trend |
|---|---|---|---|---|---|
| | Group GZ | Group GY | Group TW | $\chi^2$-test | |
| M/W | 141/150 | 98/92 | 100/100 | | |
| SBP (mmHg) | | | | | |
| Men | 120.6±1.61 | 119.8±2.11 | 137.2±2.10**,## | $p<0.001$ | |
| Women | 121.4±1.60 | 122.1±2.25 | 131.8±2.34**,## | $p<0.001$ | |
| DBP (mmHg) | | | | | |
| Men | 71.5±0.91 | 71.4±1.30 | 85.1±1.31**,## | $p<0.001$ | |
| Women | 70.7±0.89 | 70.8±1.32 | 80.2±1.25**,## | $p<0.001$ | |
| Rate of antihypertensive medication use (%) | | | | | |
| Men | 0 | 2.5 | 28.0## | $p<0.001$ | $p<0.001$ |
| Women | 0 | 9.5 | 31.1## | $p<0.001$ | $p<0.001$ |
| Hypertension (%) | | | | | |
| Men | 4.7 | 7.7** | 40.15**,## | $p<0.001$ | $p<0.001$ |
| Women | 11.2 | 13.1 | 47**,## | $p<0.001$ | $p<0.001$ |

*$p<0.01$, **$p<0.001$ *vs.* Group GZ; #$p<0.01$, ##$p<0.001$ *vs.* Group GY. Values are expressed as mean±SEM or prevalence. Group: GZ, GY, TW as defined in Table 1. SBP, systolic blood pressure; DBP, diastolic blood pressure; Hypertension includes those with SBP≧160 or DBP≧95 mmHg or those receiving antihypertensive medication.

**Table 3. Parameters in 24 h Urine in the Three Populations of Men and Women**

| Number in group | Guangzhou | Guiyang | Taiwan | ANOVA or $\chi^2$-test |
|---|---|---|---|---|
| | Group GZ | Group GY | Group TW | |
| M/W | 141/150 | 96/88 | 68/66 | |
| Sodium (mEq/d) | | | | |
| Men | 154.7±8.90 | 166.2±7.01 | 163.5±5.91 | NS |
| Women | 144.7±9.02 | 145.5±6.81 | 135.7±5.46 | NS |
| Potassium (mEq/d) | | | | |
| Men | 28.4±1.71 | 24.8±1.21* | 49.2±2.01**,## | $p<0.001$ |
| Women | 29.4±1.87 | 25.4±0.98* | 49.1±2.13**,## | $p<0.0001$ |
| Sodium/Potassium | | | | |
| Men | 6.3±0.27 | 8.0±0.45** | 3.6±0.02**,## | $p<0.001$ |
| Women | 5.5±0.18 | 6.4±0.63** | 3.0±0.16**,## | $p<0.001$ |
| Calcium (mg/d) | | | | |
| Men | 210.1±10.2 | 204.1±9.41 | 135.1±7.10**,## | $p<0.001$ |
| Women | 210.1±9.80 | 192.3±9.01 | 138.2±7.32*,# | $p<0.02$ |
| Magnesium (mg/d) | | | | |
| Men | 93.1±8.8 | 90.4±4.23 | 80.9±2.86 | NS |
| Women | 83.1±7.6 | 87.5±3.89 | 74.1±3.65 | NS |

NS, not significant. *$p<0.01$, **$p<0.001$ *vs.* Group GZ; #$p<0.01$, ##$p<0.001$ *vs.* Group GY. Values are expressed as mean±SEM or prevalence. Groups GZ, GY, TW as difined in Table 1.

4 women in the GY group, and 32 men and 34 women in the TW group were excluded from the statistical analysis of urinary variables because they met the following exclusion criteria: 1) they were taking antihypertensive drugs, which could have an effect on electrolyte excretion; or 2) they did not meet the 24-h urinary excretion of creatinine in relation to body weight that was considered to indicate a complete 24-h collection (*30*).

## Results

The group anthropometric data, BMI values and rates of obesity are summarized in Table 1. A gradient of BMI and the rate of obesity (BMI > 26.0) was observed in both genders from the GZ group through the GY group to the TW group ($p<0.001$).

In both genders, the average SBP and DBP in the TW group were much higher than those in the GZ and GY groups (Table 2). There was a signifi-

**Table 4. Blood Parameters in the Three Populations of Men and Women**

| Number in group | Guangzhou Group GZ | Guiyang Group GY | Taiwan Group TW | ANOVA or $\chi^2$-test | $\chi^2$-test for trend |
|---|---|---|---|---|---|
| M/W | 150/150 | 98/92 | 100/98 | | |
| Total cholesterol (mg/dl) | | | | | |
| Men | 159.2±3.20 | 176.7±7.01** | 188.4±5.41**,## | $p<0.001$ | |
| Women | 160.8±3.58 | 164.0±4.81* | 205.9±5.68**,## | $p<0.001$ | |
| Hypercholesterolemia >220 mg/dl (%) | | | | | |
| Men | 4.4 | 18.2** | 29.5**,## | $p<0.001$ | $p<0.001$ |
| Women | 4.6 | 11.6** | 41.9**,## | $p<0.001$ | $p<0.001$ |
| HDL-cholesterol (mg/dl) | | | | | |
| Men | 46.2±1.50 | 44.6±1.01 | 33.0±1.40**,## | $p<0.001$ | |
| Women | 44.2±0.92 | 45.9±1.21 | 35.8±1.65**,## | $p<0.001$ | |
| Glycohemoglobin (%) | | | | | |
| Men | 4.10±0.20 | 4.69±0.12* | 5.35±0.20**,## | $p<0.001$ | |
| Women | 4.02±0.21 | 4.65±0.11* | 5.34±0.32**,## | $p<0.001$ | |
| High Glycohemoglobin >6 (%) | | | | | |
| Men | 7.2 | 8.2 | 25.8**,## | $p<0.001$ | $p<0.01$ |
| Women | 8.0 | 12.6** | 22.5**,## | $p<0.001$ | $p<0.01$ |

Values are expressed as mean±SEM or prevalence. Groups GZ, GY, TW as defined in Table 1. *$p<0.01$, **$p<0.001$ *vs.* Group GZ; #$p<0.01$, ##$p<0.001$ *vs.* Group GY.

**Table 5. Coefficients of Regression of Body Mass Index (BMI) in the Populations of Men or Women**

| | Systolic blood pressure | Diastolic blood pressure | Serum cholesterol | HDL-cholesterol | Glycohemoglobin |
|---|---|---|---|---|---|
| Total Number | (289) | (289) | (246) | (203) | (306) |
| Men | 0.23** | 0.35*** | 0.19* | −0.34*** | 0.26** |
| Total Number | (286) | (286) | (253) | (253) | (299) |
| Women | 0.22** | 0.36*** | 0.38*** | −0.20* | 0.28*** |

( ) are totals of the three groups, excluding the subjects receiving antihypertension medication. *$p<0.01$, **$p<0.001$, ***$p<0.0001$.

**Table 6. Food Frequency by Dietary Questionnaire in the Three Populations of Men and Women**

| | Meat (per wk) | | Vegetable (per wk) | | Tea (cups d) | |
|---|---|---|---|---|---|---|
| | Men | Women | Men | Women | Men | Women |
| Guangzhou (Group GZ) | 4.0±0.2 | 3.8±0.3 | 3.0±0.2 | 3.2±0.1 | 10.6±0.6 | 6.1±0.2 |
| Guiyang (Group GY) | 3.8±0.3 | 3.8±0.3 | 4.9±0.2* | 5.9±0.2* | 5.6±0.2*** | 5.1±0.2* |
| Taiwan (Group TW) | 5.3±0.2*,# | 4.6±0.1*,# | 3.2±0.08# | 3.5±0.09# | 4.4±0.2***,# | 3.6±0.1**,## |
| *P*-values | $p<0.05$ | $p<0.05$ | $p<0.05$ | $p<0.05$ | $p<0.0001$ | $p<0.001$ |

Values are expressed as mean±SEM. Groups GZ, GY, TW as defined in Table 1. NS, not significant. *$p<0.01$, **$p<0.001$ *vs.* Group GZ; #$p<0.01$, ##$p<0.001$ *vs.* Group GY.

cant gradient to the proportion of those receiving antihypertensive medication from the GZ group (men 0%, women 0%) through the GY group (2.5%, 9.5%) to the TW group (28%, 31%). The same significant gradient was present for the prevalence of hypertension, defined as SBP ≧160 mmHg or DBP≧95 mmHg, and for the use of antihypertensive medication.

There were several differences in relation to the 24-h urinary electrolyte excretion (Table 3). There was no significant difference in the means of sodium excretion. The potassium excretion was greatest in the TW group and least in the GY group. The potassium excretion of the GZ group was intermediate in both genders. The sodium-potassium ratio was greatest in the GY group, less in the GZ group and least in the TW group in both genders. The calcium excretion was greatest in the GZ group and showed a negative gradient in men and women from the GZ group through the GY group to the

**Table 7. Comparison of Cardiovascular Risks Factors in Guiyang in 1987 and 1997**

| | 1987 | 1997 | $p$-values |
|---|---|---|---|
| BMI | | | |
| Men | 21.4±0.3 | 21.9±0.2 | NS |
| Women | 22.4±0.3 | 22.5±0.3 | NS |
| Obese (%) | | | |
| Men | 6.7 | 10.2 | $p<0.05$ |
| Women | 8.8 | 9.6 | NS |
| SBP (mmHg) | | | |
| Men | 114.8±1.9 | 119.8±2.1 | $p<0.05$ |
| Women | 109.3±2.2 | 122.1±2.2 | $p<0.001$ |
| DBP (mmHg) | | | |
| Men | 68.1±1.2 | 71.4±1.3 | NS |
| Women | 61.0±1.2 | 70.8±1.3 | $p<0.001$ |
| Hypertension (%) | | | |
| Men | 6.7 | 7.7 | NS |
| Women | 9.8 | 13.1 | $p<0.05$ |
| T-CHO | | | |
| Men | 158.3±2.8 | 176.7±7.0 | $p<0.005$ |
| Women | 160.2±6.3 | 164.0±4.8 | NS |
| Hypercholesterolemia (%) | | | |
| Men | 0 | 18.2 | |
| Women | 0 | 11.6 | |

Values are expressed as mean±SEM or prevalence.

TW group. There was no significant difference in the magnesium excretion, but this parameter showed a negative gradient in the same group order in both genders.

A significant gradient of the mean serum total cholesterol concentration and the prevalence of hypercholesterolemia (total cholesterol >220 mg/dl) was observed in both genders from the GZ group through the GY group to the TW group ($p<0.001$) (Table 4). The HDL-cholesterol concentration of the men was greatest in the GZ group and least in the TW group ($p<0.001$). In women, the HDL-cholesterol concentration was greatest in the GY group and least in the TW group ($p<0.001$); the values in the GZ group were intermediate. The glycohemoglobin A1c values and the prevalence of increased glycohemoglobin A1c (>6%) showed significant gradients in both genders from the GZ group through the GY group to the TW group, but these also were attenuated when an adjustment for BMI was made.

A simple linear regression analysis was applied to examine the correlations of BMI to SBP in the total populations of men and women ($r=0.23$, $r=0.22$, both $p<0.001$) and DBP in both genders (men, $r=0.35$; women, $r=0.36$; both, $p<0.0001$; Table 5). BMI was significantly positively correlated with serum total cholesterol levels in the total populations of both men and women (men, $r=0.19$, $p<0.01$; women, $r=0.38$, $p<0.0001$). Significant inverse correlations of BMI and HDL-cholesterol were seen in both genders (men, $r=-0.34$, $p<0.0001$; women, $r=-0.20$, $p<0.005$). BMI was significantly positively correlated with glycohemoglobin in both genders ($r=0.26$, $r=0.28$, $p<0.001$).

The frequency of dietary intake of meat was greater in the TW group (5.3 times a week in men and 4.6 times a week in women) and lesser in the GY and GZ groups. The dietary intake of vegetables was greatest in the GY group (4.9 times and 5.9 times a week in men and women) and lesser in the TW and GZ groups. The reverse was found for mean tea consumption (4.4 and 3.6 cups a day in the TW group compared with 10.2 and 6.1 cups a day in the GZ group for men and women, respectively), with a significant negative gradient from the GZ group through the GY group to the TW group (Table 6).

SBP, DBP and the prevalence of hypertension in the women of the GY group increased significantly over the past 10 yr ($p<0.001$, $p<0.01$, $p<0.05$) (Table 7). In the GY group, total cholesterol was significantly increased in the men and the rates of hypercholesterolemia were increased by 18.2% in the women and 11.6% in the men as compared with the rates observed 10 yr earlier.

## Discussion

Socioeconomic development, urbanization and industrialization have progressed rapidly in China over the past decade. From 1985 to 1995, the average income of Chinese people increased 4.8-fold and 3.9-fold in urban and rural areas, respectively (Year Book of China Statistics, 1995). The changes in lifestyle and behavior that often occur along with socioeconomic development and urbanization appear to be associated with an elevation of cardiovascular risks, including risk of obesity, hypercholesterolemia, increased blood pressure and increased incidence of hypertension. We thus examined cardiovascular risks among three Chinese populations, undergoing three different grades of transition.

We found significant positive associations between BMI and blood pressure in all three populations. The prevalence of hypertension was essentially associated with the degree of obesity, as demonstrated by reference to previous CARDIAC studies (*13, 14*). We found that the risk of hypertension in the TW group was similar to those in Western populations (*18*) and much greater than those in the GY and GZ groups, reflecting the lower prevalences of obesity in the latter two groups. Obesity seemed to be the factor most responsible for hypertension in the three groups.

With respect to the 24-h urinary excretion of electrolytes, sodium excretion showed no clear tendency of a gradient of values in either men or women. The sodium-potassium ratio was greater in the GY group than in the other two groups in both genders. Increased sodium excretion and an increased sodium: potassium ratio are known to be closely related to increased blood pressure (*15-17, 19*). In our studies, the well-known electrolyte effects on blood pressure were not observed. The salt intakes in the present three groups were under 10 g per d, which rate is lower than that previously reported for other regions (*13*). The intake of salt had no significant influence on blood pressure in these three populations.

Numerous epidemiological studies have detected a close correlation between dietary habits and blood pressure levels (*20*). He *et al.* suggested that blood pressure levels were attributed to lifestyle and dietary habits in the Yi population of China (*21*). Dietary changes, such as an increase in the consumption of saturated fatty acids and a reduction in the consumption of vegetable fibers, certainly contribute to an increase in body weight and blood pressure.

Various types of dietary fibers are present in vegetables and fruits and may influence the BP response (*22, 23*). Wright *et al.* reported that subjects with a highfiber intake had lower mean BP than those with a lowfiber intake (*24*), a result that was verified in a clinical study (*25*). In addition to the effects on insulin metabolism, soluble fiber intake may lower BP through increased electrolyte excretions (*26, 27*).

Tea consumption has been reported to be associated with lower cholesterol and lower BP (*28, 29*). Such effects may be related to flavonoids in tea (*30*). Flavonoids are a large group of polyphenolic antioxidants that occur naturally in vegetables and fruits and in beverages such as tea and wine (*31-33*). Both flavonoid intakes and tea consumption have been reported to be inversely associated with mortality from coronary heart disease (*31*).

In the present study, the frequency of both vegetable and tea intake was significantly inversely related with BMI, BP, total cholesterol and hypertension. The food frequency analysis revealed significantly greater meat consumption and significantly less tea and vegetable consumption in the TW group compared to the GY and GZ groups. This difference may explain in part the differences in dietary risk and beneficial factors among the three groups. To clarify a causal relation between the dietary intake of vegetables and hypertension, however, many factors must be taken into account, including biological markers and dietary habits together with cooking style, which has a marked affect on calorie and fat intakes in China.

In accordance with numerous other epidemiological studies (*34*), we found that HDL-cholesterol levels were significantly inversely related to BMI. Jiang *et al.* suggested that dietary fiber was positively related to HDL-cholesterol in a multivariate analysis (*35*). In our study, the prevalence of hypercholesterolemia was greater in the TW group than in the other two groups in both genders. A significant positive association between cholesterol levels and BMI was observed in all three groups, and HDL-cholesterol had a negative gradient from the GZ group through the GY group to the TW group in both genders. Several studies have demonstrated that dietary fiber selectively reduces LDL-cholesterol and increases HDL-cholesterol (*36, 37*). Our study also confirmed that, among the three populations, those consuming diets rich in vegetables and low in meat showed relatively lower serum total cholesterol levels and relatively higher HDL-cholesterol levels.

Glycohemoglobin is regarded as a biological indicator of hyperglycemia (*38*). The mean levels of glycohemoglobin and the rates of a high concentration of glycohemoglobin ($>6.0\%$) showed significant gradients in both genders from the GZ group through the GY group to the TW group. A significant elevation of glycohemoglobin when the BMI was above the highest quartile in men aged $<54$ yr and in women aged $<64$ yr has been reported in a Chinese population (*39*). These results may indicate that a greater prevalence of diabetes mellitus exists in the present TW group. The greater prevalence of obesity in the TW subjects may be related to their hypertension, hypercholesterolemia and higher glycohemoglobin. Since socioeconomic development, urbanization and industrialization have progressed in Taiwan, these results may be attributable in part to the so-called westernization of lifestyles in the TW population.

In the GY population, the consumption of meat, eggs and oil has increased by 63.8%, 84.1% and 38.2% over the past 10 yr, suggesting marked lifestyle changes. Our results showed that both SBP and DBP increased significantly over the past 10 yr in both genders of the GY population. Both the total cholesterol level and the rate of hypercholesterolemia also increased over the same period in both GY genders, indicating increased cardiovascular risks in the GY population in association with the recent socioeconomical development.

In conclusion, our results suggest that obesity is the factor most responsible for hypertension in the three Chinese populations studied. The urbanized Taiwan population was confirmed to have significantly greater cardiovascular risk factors than the other two Chinese populations. Cardiovascular risk factors have also increased over the past 10 yr in the Guiyang population. From these results, we can speculate that Chinese peoples under a transition from traditional Chinese lifestyles to a Western lifestyle have potentially increased their susceptibility to cardiovascular risk factors.

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