

# Epidemiological and nutritional research on prevention of cardiovascular disease in China

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Anthropological evidence suggests that regional differences in eating practices may be characterized by sub-ethnicity. Hakka is one sub-ethnicity who still retain a unique way of life in China. A field survey on diet and health among the Hakka people was undertaken in 1994. Approximately 200 participants were interviewed for their medical history, life-style and food habits. Blood pressure, body mass index, blood sample, 24 h urine and electrocardiogram were collected. The food samples taken from one tenth of the participants were analyzed for the ingredients in their daily meals. From this survey the prevalence of hypertension in Hakka was approximately 10%. The sodium/potassium ratio was lower than that in Guangzhou and comparable with that in Okinawa, the island of longevity in Japan. For men, taurine level was found to be close to that in Mediterranean countries, where there is low mortality from cardiovascular diseases. For women, the taurine level was even higher, approximating that of Japanese women, who show the greatest longevity and lowest cardiac mortality worldwide. Less obesity was found in Hakka people than that in the US, Canada or Japan. These findings suggest that the following are the major reasons for these positive findings: the Hakka people maintain traditional food habits and maintain active awareness of their health; the major foods are rice, fish, vegetables and fruits; wide use of soybeans; extensive consumption of visceral organs which have rich source of trace elements. These eating practices and nutritional patterns may be beneficial factors for preventing atherosclerosis and hypertension.

## Epidemiology: Nutrition: China

### Background

Health status of an individual is a function of preventable risk factors and their determinants. In addition to genetic predisposition, dietary factors play an important role in the determination of an individual's health. Cardiovascular disease, one of the most widely studied chronic diseases, is said to be preventable because the several established risk factors for this disease are of dietary environmental consequence. Thus, the report of the WHO Expert Committee on the prevention of Coronary Heart Disease has provided the rationale for a community wide strategy for the primary prevention of atherosclerosis and coronary heart disease by improving eating patterns and other aspects of life-style. Dietary improvement has, thus, been given the most important position in the strategies for the prevention of the major adult cardiovascular diseases (CVD).

Although the necessity and the feasibility of the primary prevention of CVD through dietary modification have been

well recognized by many epidemiological or experimental observations, knowledge about an optimal diet is still limited and qualitative, and inadequate findings are available to permit a quantitative description of the components. The present study has been proposed based on this background to assess dietary conditions of various populations with different rates of the major adult CVD. It is aimed to apply standardized and objective methodologies, and to contribute to the establishment of a more scientific basis for the dietary essential goal of 'Health For All By The Year 2000.'

### Items and methods for survey

#### *Study design and subjects*

With the cooperation of the Guangdong Provincial People's Hospital, Guangdong Cardiovascular Institute, the WHO CARDIAC Study was conducted for a cross-sectional epidemiological and nutritional research on prevention of

**Abbreviations:** BMI, body mass index; CVD, cardiovascular diseases; HDL-C, HDL cholesterol; LDL-C, LDL cholesterol; TC, total cholesterol.

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cardiovascular disease among the Hakka people of Meixian in Guangdong province. Kyoto University, Graduate School of Human and Environmental Studies provided scientific instruction for this survey. Meixian County People's Hospital provided enhanced cooperation. The study was conducted in the county of Meixian approximately 430 km from Guangzhou in eastern Guangdong in 1994. Two hundred men and women aged 35–54 were randomly sampled for this survey. Questionnaires were given by a well-trained cardiologist. Questions included medical history, life-style and food habits. Cardiovascular risk factor assessments included blood pressure, anthropometry, blood tests, urine tests, electrocardiogram and samples of daily food eaten.

#### *Food samples*

Food samples were collected from each of twenty participants and these were homogenized for the analysis of the ingredients in their meals at the day of interview. Photographs of the kinds of food and the amount of food were recorded. The chemical analysis of a portion of the homogenized sample foods was carried out in Japan after the survey.

Questions of: (1) family structure, (2) type of soybean used, (3) frequency of eating boiled rice per week, (4) the amount of fish per week, (5) types of meat per week, (6) the way vegetables were eaten, (7) types of fruits eaten, (8) types of food per day, were also asked.

#### *Blood pressure measurement*

To minimize observer bias in blood pressure measurements, the same well calibrated automatic sphygmomanometers were used in all participating centers. Each participant was seated for several minutes before the measurements were taken. Readings were from the right arm.

#### *Height and weight*

The same manual was used as in the MONICA Project. Height and weight were measured for each participant as part of the general information. Body weight was measured on a spring scale with the participant wearing light indoor clothing without shoes. Height was measured with a right angle device on persons without caps or shoes. Body mass index (BMI), the weight in kilograms divided by height in meters squared, was then calculated as an index for obesity.

#### *Blood tests*

Blood samples were collected from persons who had fasted for over 3 h. At least 10 ml of blood was collected from the antecubital vein. After taking a small amount of blood for hematocrit and hemoglobin determinations, the samples were immediately centrifuged to separate serum at 3000 rpm for 15 min. Serum separated equally into two test tubes was stored at  $-20^{\circ}\text{C}$  and sent to the analysis center at the earliest opportunity. The items for blood

sample measurement were: total cholesterol; uric acid; albumin; fatty acids; hematocrit; hemoglobin; etc.

#### *Urine tests*

Twenty-four hour urine was collected using an 'aliquot cup' (a newly devised vessel for collecting urine). One twentieth of voided urine each time was collected into an attached disposable cartridge. The urine sample was collected after the first voiding in the morning until the first voiding the following morning. Persons were further interviewed regarding the completeness of urine collection at the survey. Three major meals should be included during this sampling period. The cartridge was stored at  $-20^{\circ}\text{C}$  and sent to the analysis center at the earliest opportunity. Biological markers of the urine samples examined were sodium, potassium, magnesium, calcium, urea nitrogen and creatinine.

#### *Others*

Electrocardiogram was checked and valuable findings on heart function and health were collected. Habitual smoking and alcohol intake were examined by questionnaires for additional cardiovascular risk factors. The same procedures as those used in the MONICA Project were applied.

#### **Quality control**

A high response rate was extremely important, since non-respondents tend to have different behavioral and health characteristics from the rest of the sample, and their omission, therefore, can result in bias. A 90 % response rate may be a reasonable goal. The characteristics of non-respondents were checked and vigorous efforts were taken to achieve requirements. Quality control methods were prepared by modifying the MONICA Project protocol, especially with regard to measurements made in the field, most particularly the blood measurements. Various variables of blood, urine and food samples were sent to Japan and measured at a single center using standardized methods.

#### **Main results from Hakka people and discussion**

We conducted the present study in the Hakka people of Meixian. The Hakka are the Han People originating from Northern China of the center Yellow River bank. They migrated from a northern part to a southern part 2000 years ago to escape from the invasion of foreign nations and the migration was repeated. The Hakka people have maintained a unique way of life. Of all the Chinese provinces, Guangdong has historically the largest number of Hakka immigrants.

The medical examinations carried out in Hakka showed some interesting findings. The prevalence of hypertension was approximately 10 %, only half of that found in Japan. The sodium/potassium ratio in Hakka was lower than that in Guangzhou and comparable with that in Okinawa, the island of longevity in Japan. For men in Hakka, the taurine level was found to be close to that of Mediterranean

countries, where there is lower mortality from CVD than most western countries. For women, the taurine level was higher, approximating to that of Japanese women, who show the greatest longevity and lowest cardiac mortality worldwide. Less obesity was found in the Hakka people than that in the US, Canada or Japan. These findings suggest that the following points were the major reasons for these positive findings: (1) the Hakka people maintain traditional eating habits and maintain active awareness of their health, (2) the major foods of the Hakka are rice, fish, vegetables and fruit, which may contain factors against the adverse effect of salt, (3) the wide use of soybeans, which have beneficial factors in preventing hypertension, (4) the extensive consumption of visceral organs, which are a rich source of trace elements that are good for preventing atherosclerosis, (5) the Hakka people regularly eat fruits rich in dietary fibers. These not only have adverse effects for salt, but also contain large amounts of potassium that plays a role in preventing hypertension.

### Food practices and nutritional status in China

Traditionally, the Chinese are family orientated. It is not surprising to find that family members form an important part of the social network system in China. Social activities were perceived to be very important to health status and well being. Moreover, the majority enjoy moderate social activities usually in a family setting and private home surroundings. The family meal setting is crucial to the prevailing notion of the Chinese way of eating. At a family meal setting, junior members are taught chopstick usage, the conduct of eating and table manners. More often in meal surroundings, family members or their guests sit at a round table to enjoy the eating occasion and to relax. Chopsticks are traditional serving utensils and are unique to the Chinese eating principle. Dinner is the main meal of the day when the family eats together. Stir-frying is used to prepare most homemade dishes. Condiments, such as spring onions, ginger and garlic, are used regularly in cooking. Foods are normally purchased from a grocer or free market.

Social network and activities have been reported to be protective against cardiovascular mortality in two prospective studies. However, the outcomes were more profound in the aged. The southern Chinese had a lower daily total energy intake than the north population, particularly among men. The total fat intake, the intake of alcohol and the per cent energy intake of total fat and alcohol was much lower among the southern Chinese than the north (Zhou *et al.* 1992). However, the daily protein intake, especially animal protein intake, was higher than many other areas of China. There were no differences in the per cent energy intake of protein. The southern Chinese had a much higher daily intake of carbohydrates among the Chinese. Generally, the daily intake of micronutrients was lower in south China. The intake of calcium per day was approximately 20 % less than the Recommend Dietary Intakes for Chinese (Liu *et al.* 1997).

Dietary practices and nutritional status in China are substantially different from the West. First, food variety appears to be much less in China, being limited to locally

grown foods that are in season at the time of the survey. A second major difference between Chinese and Western diets is represented by the far greater contribution of plant foods to the Chinese diet.

The present and previous Chinese studies show that typical rural Chinese diets include a high proportion of cereals and vegetables and a low content of meat, poultry, eggs and milk. In addition, these diets result in high intakes of dietary fiber and low intakes of protein (especially animal protein), fat, calcium, retinol and riboflavin. Such diets, of course, are very different from those of industrially developed countries.

### Preventable CVD risk factors in China

The Hakka people had more favorable cardiovascular risk profiles compared with the northern populations in China in terms of population mean blood pressure, the urinary sodium/potassium concentrations and the prevalence of overweight/obesity. The prevalence of cigarette smoking was lower in Hakka compared with values derived from the 1983–1984 Epidemiological Study of Cardiovascular and Cardiopulmonary Disease Risk Factors in Four Populations in China. There was a national decline in the prevalence of cigarette smoking between 1983 and 1989. The mean blood pressure was lower in southern Chinese than the mean average of the whole of China.

Mean consumption of fat and cholesterol in Chinese was lower than that of Americans. Chinese had much lower plasma cholesterol concentrations compared with North Americans. This probably, in part, explains the much lower prevalence of overweight, obesity and coronary heart disease (Zhou *et al.* 1994). Obesity is rare in China. As a study from South China (Folsom *et al.* 1994) showed that mean BMI ranged from 20.1 to 21.9 kg/m<sup>2</sup> across the four area- and sex-groups. Mean waist/hip ratio was 0.84 in men and 0.80 in women.

### Determinants of cardiovascular risk factors

#### *Dietary factors*

Total energy intake and intakes of saturated fatty acids and alcohol were the most important determinants of dietary related cardiovascular risk factors. A higher daily total energy intake was protective against elevated diastolic blood pressure in men and women. However, there was a weak and adverse effect of total energy intake to systolic blood pressure. An increased intake of saturated fatty acids predicted the elevation of plasma total cholesterol (TC) and LDL cholesterol (LDL-C) concentrations and an increased BMI in men. The intake of saturated fatty acids also had an adverse effect on diastolic blood pressure in men and plasma triglycerides in women. In contrast to the intake of saturated fatty acids, the per cent energy of saturated fatty acids showed a negative relationship to diastolic blood pressure in men and plasma triglycerides in women. Thus, increases in the intake of fatty acids may also be unfavorable to cardiovascular health status, particularly blood pressure (men and women), plasma triglycerides, BMI and fasting glucose levels (women only). For

example, an increased monounsaturated-to-saturated fatty acid intake ratio explained, in part, the raised systolic blood pressure in men and women. Moreover, the polyunsaturated-to-saturated fatty acid intake ratio was positively related to BMI and fasting glucose levels in women. It appears that the intake of saturated fatty acids had a predictive power of classic cardiovascular risk factors such as diastolic blood pressure, atherogenic lipoproteins and BMI in men, and plasma triglycerides in women.

Alcohol intake, as a nutrient, predicted an increased BMI in women. The per cent energy intake of alcohol also explained, in part, the elevation of systolic blood pressure in women, and HDL cholesterol (HDL-C) levels in men. More consistent models in the relationships between alcoholic beverages and cardiovascular risk factors were identified.

The intake of beta-carotene was negatively related to plasma TC, HDL-C and LDL-C concentrations in men and the intake of retinol equivalents were also negatively related to LDL-C concentrations in women. This suggests that an increased intake of retinol equivalents (beta-carotene and retinol) may lower atherogenic lipoproteins, although the effect of beta-carotene on HDL-C fractions remains to be confirmed.

Observations in Guangzhou, South China showed that the 'dietary lipid score' was positively associated with TC, LDL-C and HDL-C, specifically, dietary cholesterol was positively associated with serum TC. Saturated fatty acids and monounsaturated fatty acids were positively correlated with HDL-C (Liu *et al.* 1994).

A higher intake of potassium and/or in relation to sodium intake was associated with a lower level of lipoproteins in women. Since potassium is rich in a wide range of foods (animal foods, natural produce of processed foods), it was of great importance to identify the food source of potassium that is responsible for the relationship. It is also possible that potassium intake is a marker for food variety, which was shown to be favorable to both plasma TC and LDL-C levels in food intake models in women.

#### Body fat

Abdominal adiposity, represented by an elevated waist/hip circumference ratio, is associated with elevated levels of several cardiovascular risk factors. Findings from Western populations indicate that the waist/hip ratio is positively associated not only with risk factors, but also with the incidence or prevalence of cardiovascular disease (Larsson *et al.* 1984; Folsom *et al.* 1991). Part of this association with cardiovascular disease undoubtedly is the result of higher physiological risk factors (e.g. atherogenic lipids) in those with greater visceral adiposity. Most existing studies have also claimed 'independent' contribution of the waist/hip ratio to cardiovascular disease.

#### Blood pressure

Findings from a Chinese cohort study implied that people with high normal blood pressure have a higher risk of developing hypertension than do other non-hypertensives, which supports the use of the updated classification of

hypertension in the new JNC guidelines. Previous prospective studies on precursors of hypertension (Selby *et al.* 1990; Garrison *et al.* 1987) have shown a baseline blood pressure level and BMI (or relative body weight) to be consistently the major predictors of hypertension. Other commonly reported predictors include heart rate and alcohol use, whereas a correlation with cigarette smoking or serum lipids has been less consistent. In the case-control study by Selby *et al.* (1990), association of heart rate with hypertension risk, which remained significant in multivariate analysis adjusted for other standard risk factors, was no longer present after controlling for baseline blood pressure.

#### Serum lipids

Findings on the correlation of serum lipids assessed in Chinese were similar to those for western populations (Linn *et al.* 1989). BMI, smoking, alcohol intake and exercise level explained some, but not all, of the variability in plasma lipids across the Chinese population samples. The magnitude of associations was generally similar across the four cities and settings of north (Beijing) and south (Guangzhou) Chinese samples, although the regression coefficients of triglyceride and HDL-C on BMI were of lower magnitude in the Guangzhou rural sample than in the other three samples. BMI in the Chinese study appeared to be more strongly associated with lipids than in the western samples (Tao *et al.* 1992). Smoking and exercise appeared to be related less strongly. For example, a unit increase in BMI was associated with a predicted decrease in HDL of 1.2 mg/dl in Chinese men and of 0.9 mg/dl in Chinese women; in similar aged western adults, the value was approximately 0.7–0.9 mg/dl. The findings from the recent studies of low serum TC, LDL-C, triglyceride and high HDL-C in Chinese populations, who had low rates of coronary heart disease, lends further support to the judgement that the desirable level of serum TC for adults should be below 200 mg/dl.

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