Cardiovascular disease risk factors are highly prevalent in the office-working population of Nanjing in China

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1. Introduction

With increasing modernization in China, cardiovascular diseases (CVD) have become one of the major diseases causing significant morbidity, disability and mortality among Chinese. Almost three million people in mainland China died of CVD every year that accounted for about 40% of all-cause mortality [1]. The ongoing deterioration in CVD risk factors seems to be the major reason that induces the surge of CVD in China.

There are modifiable and non-modifiable factors that contribute to CVD risk. Non-modifiable risk factors such as age, gender, race, and family history are those that cannot be changed. Modifiable risk factors including hypertension, dyslipidemia, smoking, diabetes, obesity, and sedentary lifestyle are those that can be altered or eliminated through proper management. More the risk factors, higher the risk of developing CVD. According to the 1st NHANES Epidemiologic Follow-up Study with data after follow-up for 21 years, the relative risks of coronary heart disease after adjustment for age, gender, race and education in adults with 1, 2, 3 and ≥4 risk factors (high blood pressure, high cholesterol level, diabetes, overweight, and smoking) were 1.6, 2.2, 3.1, and 5.0, respectively as compared to those who had none of these risk factors. Relative risks for stroke associated with the same risk levels were 1.4, 1.9, 2.3, and 4.3, respectively [2]. Although CVD are emerging in China, little has been known about their level of the CVD risk factors. Relevant information on the prevalence of CVD risk factors is essential to the government and health professionals in China to set goals and objectives for effective CVD intervention programs.

The aim of this study is to establish a profile of the modifiable CVD risk factors in the working population in a representative urban city in China. Working population has shown to be “high risk group” for CVD.
Their health status is of major significance due to the large population in China and the adverse economic impact if a substantial proportion of working people are affected. Information collected from this study may help the health care system adopt relevant and appropriate plan to prevent the further deterioration of CVD risk factors in China.

2. Methods

2.1. Study population

Nanjing is the capital of Jiangsu Province and located in the east of China. It includes 6 urban, 5 suburban and 2 rural districts, holding 7.4 million permanent residents, of whom, more than 75% are urban population. The survey was approved by Jiangsu Provincial Health Administrative Department and its Ethics Committee.

Subjects of the study came from seven work units including government offices, scientific research institutions and banks in four major urban districts of Nanjing. All staff of the work units were invited to attend for a free check-up to screen for CVD risk factors. The invitations were sent through telephone calls with prior poster notification by their unit infermiers. Out of 3223 initial invitations, 3024 (91.0%) responded and subsequently volunteered to take part in the study. All subjects agreed to participate into the study had provided informed consent. Those who had history of coronary heart disease, stroke and/or diabetes were excluded from the study.

In the period between October 2003 and March 2005, 3024 subjects were recruited to the study, of whom 345 defaulted the assessment due to job reason or having acute illnesses and another 31 had incomplete data collection. Hence, 2684 subject completed the survey and with data available for the present analysis. All subjects received a physical and laboratory evaluation in their work sites. Information on each participant’s lifestyle was obtained using a self-reported questionnaire modified from the semi-quantitative food frequency questionnaire (FFQ) [4,5] and the Nurses’ Health Study questionnaire [6–8]. Data on medical history, smoking, alcohol consumption, exercise, and dietary habits were collected.

2.2. Measurements

On the day of assessment, all subjects were asked to complete a questionnaire and underwent simple health tests. Data collected included past medical history, family history of significant diseases, smoking history, social background (occupation and education level), level of physical activity and dietary habits. The health test included measurements of blood pressure, body weight, waist circumference and blood tests. Blood pressure (BP) was measured twice using a standard mercury manometer in the sitting position after the subject rested for at least 15 min. The average of the two measurements was recorded. Body weight, height and waist circumference were measured with light clothing on but shoes off. The minimum waist measurement between xiphisternum and umbilicus was taken as the waist circumference. BMI was calculated as weight (kg) divided by squared height (m²).

Venous blood was collected from the antecubital vein after a 12 h overnight fast. A 75-gram anhydrous glucose load oral glucose tolerance test (OGTT) was performed after fasting blood samples were collected. Blood for glucose assay was collected using sodium fluoride (NaF) bottles. Plasma glucose levels were determined by the glucose-oxidase method. Serum total cholesterol (TC), high-density lipoprotein-cholesterol (HDL-C), and triglyceride (TG) concentrations were determined enzymatically. Low-density lipoprotein cholesterol (LDL-C) was calculated using the Friedewald’s formula [9].

2.3. Definitions of CVD risk factors

We defined seven CVD risk factors as the following (see also Table 1):

(1) Smoking—Smoking habits were classified as current habitual use. Both ex-smokers and those who never smoke were defined as non-smokers.

(2) No or minimal physical activity—Physical activity was categorized into 3 groups, namely, frequent, moderate, or no or minimal physical activity. Frequent activity was defined as doing vigorous exercise with sweating (such as swimming, running, dancing, cycling) ≥3 times per week and lasting >10 min each time, or light exercise without sweating (such as walking, household works) ≥7 times per week and lasting ≥60 min each time. Moderate activity was defined as either doing vigorous exercise with insufficient frequency or duration (i.e. <3 times per week or lasting <30 min each time). No or minimal physical activity was defined as either not doing any exercise or doing light exercise <7 times per week and lasting <60 min each time [6–8].

(3) Unhealthy dietary habits—Subjects were defined to have unhealthy dietary habits if they had 3 or more of the following: preference to have salty food, preference to have red meat, diets without vegetables and fruits, and eating ≥3 eggs per day [46,10].

(4) Obesity—BMI≥28 kg/m² [11–13] and/or WC≥90 cm in men or ≥80 cm in women [14].

(5) Hypertension—Blood pressure ≥140/90 mm Hg and/or current use of antihypertensive agents.

(6) Dyslipidemia—Having 1 or more of the following: TC≥5.18 mmol/L; HDL-C<1.04 mmol/L; LDL-C≥3.37 mmol/L and TG≥1.70 mmol/L [15].

(7) Hyperglycemia—Fasting plasma glucose (FPG)≥5.6 mmol/L and/or 2 h post-OCTG glucose (2 h PG)≥7.8 mmol/L.

2.4. Statistical analysis

Statistical analysis was performed using the SPSS (version 15.0) software on an IBM compatible computer. Continuous variables were presented as mean±SD and categorical data as number (%). Difference in means between groups was tested using one-way analysis of variance (ANOVA) and Chi-square test where appropriate. A P-value<0.05 (two-tailed) was considered to be statistically significant.

3. Results

Of the 2648 subjects, 1611 (60.8%) were men and 1037 (39.2%) were women. Their mean age was 47.4±11.6 years (median 46 years, range 23 to 79 years). Of the 1037 women, 361 (34.8%) were postmenopausal. Table 2 shows their clinical and biochemical characteristics. Compared to women, men had higher BMI, BP, PG, TG and lower HDL-C. Table 3 summarizes the CVD risk factors of the subjects. The average number of CVD risk factors was 2.8, and 95.6%, 79.4% and 55.6% of the subjects had ≥1, ≥2 and ≥3 risk factors, respectively. Men had a higher rate of smoking, hypertension, dyslipidemia, hyperglycemia, but lower rate of no or minimal physical activity as compared to women.

Regarding dietary habits, the percentage of subjects having the five unhealthy dietary habits, namely, preference to salty food, sweet food, red meat, diets without vegetables and fruits, and eating ≥3 eggs per day, were 41.3%, 24.8%, 25.7%, 8.8%, and 61.1%, respectively. More men favored to have salty food (44.6% vs. 36.1%, p-value<0.001) and red meat (30.8% vs. 17.8%, p-value<0.001) than women. There was no difference in obesity between men and women with 7.0% of them (8.4% in men vs. 4.8% in women) having general obesity (based on BMI) and 32.1% (32.4% in men vs. 31.5% in women) having central obesity (based on WC). Using the Chinese definition with BMI≥24 kg/m², 45.4% of them were overweight/obese (55.9% of men, 28.9% of women).

Among the 31.8% of subjects with hypertension, 24.2% were current user of antihypertensive agents and 7.6% were newly diagnosed with blood pressure ≥140/90 mmHg. For dyslipidemia, none of the subjects are known if on medications, 35.8% of the subjects had 2 or more lipid abnormalities and there was a significant difference between men and women in hypertriglyceridermia and low HDL-C. According to the OGTT results, men had more glucose abnormalities (IGF, IGT or diabetes) than women (25.1% vs. 19.5%, p-value<0.05). Newly diagnosed diabetes by OGTT was 5.9% in our study (6.5% in men vs. 4.8% in women, p-value<0.001).

The average number of CVD risk factors was 2.8 (men vs. women: 3.0 vs. 2.3, p-value<0.001). The number increased with age, but showed an obviously gender differences (Figs. 1 and 2). Men had

<table>
<thead>
<tr>
<th>CVD risk factors</th>
<th>Definition</th>
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BMI, body mass index; WC, waist circumference; TC, total cholesterol; HDL-C and LDL-C, high- and low-density lipoprotein cholesterol; TG, triglyceride; PG, plasma glucose
In developing countries, the increase in CVD burden is largely the result of an increase in the prevalence of risk factors and a relative lack of access to relevant interventions. As a result, a relatively younger population in developing countries is afflicted by CVD as compared to more developed areas. This has led to an increased mortality in the working population [16]. In the present study, we examined 7 modifiable CVD risk factors, namely, smoking, inadequate physical activity, unhealthy diet, obesity, hypertension, dyslipidemia, and hyperglycemia, in a working population without past history of CVD or diabetes in Nanjing, China. We found that more than 3 quarters (79.4%) of these Chinese adults had 2 or more CVD risk factors, and more than half (55.6%) of them had 3 or more CVD risk factors. Furthermore, the number of CVD risk factors increased with age, especially among women, of whom the menopausal status seemed to account for this.

The InterAsia and the Sino-MONICA study evaluated the prevalence and extent of CVD risk factors in several regions in China, including Beijing, the capital [17,18]. The Sino-MONICA study was probably the first of its kind to evaluate CVD risk factors in a large Chinese population [18,19]. However, it was done many years ago (1987–1993) with inaccurate data collection in some of the participating areas. With recent rapid environmental and lifestyle changes in China, more updated surveys on CVD risk factors are indicated.

In the InterAsia study that was conducted in 2000–2001 83.1%, 53.6%, and 24.5% of Chinese urban adults had respectively ≥1, ≥2, and ≥3 modifiable CVD risk factors (dyslipidemia, hypertension, diabetes, cigarette smoking, and overweight) [17]. Our figures were even higher but we extended the CVD risk factors to cover physical activity and dietary habits. Importantly, though the age ranges are similar between subjects of InterAsia study [17] and that of our study, we concentrated on those working populations who are keys for economic development of the country. The high prevalence of CVD risk factors in this group of subject has a significant impact on their health status.

### 4. Discussion

In developing countries, the increase in CVD burden is largely the result of an increase in the prevalence of risk factors and a relative lack of access to relevant interventions. As a result, a relatively younger population in developing countries is afflicted by CVD as compared to more developed areas. This has led to an increased mortality in the working population [16]. In the present study, we examined 7 modifiable CVD risk factors, namely, smoking, inadequate physical activity, unhealthy diet, obesity, hypertension, dyslipidemia, and hyperglycemia, in a working population without past history of CVD or diabetes in Nanjing, China. We found that more than 3 quarters (79.4%) of these Chinese adults had 2 or more CVD risk factors, and more than half (55.6%) of them had 3 or more CVD risk factors. Furthermore, the number of CVD risk factors increased with age, especially among women, of whom the menopausal status seemed to account for this.

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inactivity is always regarded a major CVD risk factor [23,24]. Our and CVD in the general population [22]. Regular physical activity of at vegetables was associated with lower CVD risk, while high salt intake, compared to men.

It is now well established that lifestyle and daily habits, including smoking, physical activity and diet, are fundamental determinants of CVD risk. Our study showed that 47.5% men and 1.8% women were smokers. These figures were less than that of the 1996 China National Prevalence Survey (66.0% men and 3.1% women aged 15 years or older) [20]. One probable reason was that most of our subjects were white collars with 76.8% having high education background (college or above). As Jiang et al. reported in the Guangzhou Biobank Cohort Study Phase 3 (2006–2007), current and ex-smokers tended to have a lower education level [21].

An inverse association has been reported between physical activity and CVD in the general population [22]. Regular physical activity of at least moderate intensity reduces the risk of CVD and physical inactivity is always regarded a major CVD risk factor [23,24]. Our results indicated that most of the working people preferred to be sedentary, and inadequate physical activity seemed to be an important, if not the most important, CVD risk factor in China. Our study was also in accord to data from other local and western literature that more women were physically inactive [25] as compared to men.

Several studies have reported that consumption of fruits and vegetables was associated with lower CVD risk, while high salt intake, diet enriched with sugary content and high intake of red meat were associated with increased risk in CVD [26–29]. Egg, as an important source of cholesterol, was also linked to CVD risk and related mortality [10,30,31]. Against such a background, we selected the following five typical unhealthy diets according to Chinese culture: preference to salty food, sweet food, red meat, diets without vegetables and fruits, and eating ≥3 eggs per day. We found that more than one third of our subjects had 3 or more of these unhealthy dietary habits and more men than women preferred to take salty food and red meat.

Recently, there is a huge economic bloom in China with substantial increase in family income. Chinese people have experienced many dramatic changes in their lifestyles including higher calorie intake, more cholesterol in their diet, and reduction in physical activity, which may underlie many metabolic disorders, such as obesity, hypertension, dyslipidemia and hyperglycemia. The InterAsia study in the year 2000 noted that dyslipidemia was found in 54%, hypertension in 26%, diabetes in 5%, current smoking in 34%, and overweight in 28% of their subjects [17]. Compared to the InterAsia study, our data from the present survey, with the exception of smoking, showed an even more alarming pattern. In particular, the rate of obesity is rapidly surging up in the Chinese population [12,32]. Nearly one half of our study subjects were suffering from overweight and/or obesity. It is important to note that there were significant geographic variations in CVD risk factors in China [17,19]. However, evidence was accumulating that the clustering of CVD risk factors in Chinese was not uncommon.

Hypertension was reported to the most prominent CVD risk factor among Chinese [33,34]. However, our results showed that lipid abnormalities were the most prevalent CVD risk factors. Interesting, more than one third of the subjects had combined dyslipidemia, and none of them are known to the subjects and receiving dietary intervention or medications reflecting this risk factor is very much under-recognized and under-treated. In accord to the study by Goff et al., we found that men were more likely than women to have lipid problems [35].

The number of CVD risk factors increased with age. The trend in men was comparatively modest with a dip after age of 60 years. Women showed a much steeper rise with the number exceeded men after the age of 60 years. It is well established that menopause related estrogen deficiency in women increases the risk of CVD [36]. Our results were in accord to published literature that Chinese postmenopausal women had worse blood pressure, lipids, and glucose metabolism, and an alarmingly increase in CVD risk as compared to premenopausal women.

The study had several limitations that restricted the generalizability of our findings. Firstly, the data primarily came from cross-sectional survey. The pattern of CVD risk may be time and place specific, hence, information of current report may not be generalized to other parts of China. Secondly, the data was obtained from volunteers and through self-reporting on physical activity, smoking, and diet, which might affect the reliability of the results. The element of self selection of studied subjects implies they may not be coming from a random representative sample. Thirdly, physical parameters and blood tests were performed on a single day, which might induce systemic errors. Hence, we measured BP twice and performed OGTT to collect two plasma glucose specimen so as to improve the internal validity of the study. Finally, our subjects came from a working population, who had similar and narrow scope of socioeconomic status. However, most of our findings were consistent with epidemiological studies of Chinese general populations.

5. Conclusions

The present study indicated that CVD risk factors were common in the working populations in China. Most of these people (four fifth) had 2 or more and half of them had 3 or more of the 7 CVD risk factors. The number of CVD risk factors increased with age. Overall speaking men had more risk factors than women, but the risk in postmenopausal women was exceedingly high. Effective interventions and treatment against CVD risk factors should be adopted in the high risk populations, which could greatly reduce the future burden of CVD in China.

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