Study Profile

# Cohort Profile: The Fangshan Cohort Study of Cardiovascular Epidemiology in Beijing, China

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## ABSTRACT

**Background:** Urbanizing rural areas in China face a rapidly growing cardiovascular disease burden. Epidemiologic studies and effective preventive strategies are urgently needed.

**Methods:** The Fangshan Cohort Study is a prospective study that began in 2008 and targets local residents aged 40 years or older living in 3 towns in the Fangshan district of Beijing. The baseline examination included a questionnaire on medical history, health knowledge, and behaviors related to cardiovascular disease, as well as physical and blood biochemical examinations. The questionnaire survey will be readministered every 2 years. A system for surveillance of mortality and morbidity of cardiovascular disease is under development.

**Results:** A total of 20 115 adults (6710 men and 13 405 women) were investigated at baseline (participation rate = 84.5%). The data indicate that overweight/obesity is a serious public health issue in Fangshan: average body mass index was 25.4 kg/m$^2$ among men and 26.5 kg/m$^2$ among women, and the prevalences of overweight and obesity were 43.6% and 10.3% among men and 47.0% and 17.7% among women.

**Conclusions:** The Fangshan Cohort Study will provide data on cardiovascular risk factors and disease profile, which will assist in developing appropriate prevention and control strategies for cardiovascular disease in rural Chinese communities.

***Key words:*** risk factors; cardiovascular disease; rural population; cohort study; China

## INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death in the world and accounted for 23.6% of all deaths in 2008.[1] Mortality from CVD has declined in high-income countries but is increasing in many developing countries, such as China.[2] Indeed, China is facing a growing epidemic of CVD.

China is a large agricultural country. In 2006, 737 million people were living in rural communities—56% of the entire Chinese population.[3] In China, an urban area is defined as a prefecture-level city or larger community and a rural area as a county or smaller community. There are 4 economic categories for rural areas. Annual per capita net income (in renminbi) for rural residents is classified as 3000 RMB or higher, 2000 to 2999 RMB, 1500 to 1999 RMB, and less than 1500 RMB for first- to fourth-class rural areas, respectively.[4] The income gap between urban and rural areas has widened with the increase in economic development that began in the 2000s. Therefore, many young workers migrate to large and medium-sized cities to seek jobs, leaving elderly people in the countryside. Along with the structural transformation of the economy, lifestyles (including diet and physical activity) have also changed. The traditional diet is made up mainly of cereals and is low in fat and calories and high in carbohydrate and dietary fiber. During the last 20 years, consumption of cereals has decreased rapidly and consumption of animal products has

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increased,[5] which may have accelerated the epidemic of CVD.[6,7] In some developed rural areas, cardiovascular disease morbidity and mortality exceed levels in urban areas.[8–10] However, because of the lack of health awareness, uneven distribution of health resources, long distances to hospitals, and low incomes, rural areas in China may have more challenges in preventing and controlling CVD.

Large-scale cohort studies have examined the secular trend and epidemiologic characteristics of CVD in China.[7,11–13] However, these cohort studies were conducted in the 1990s and ended in around 2000. Thus, data for recent years are lacking, especially for rural populations. In addition to academic research, the Chinese government is addressing the issue of chronic disease in rural areas. For example, the New Rural Cooperative Medical System was established in 2003.[14] This health care system targets the rural population and is organized, led, and supported by the government, with the voluntary participation of rural residents. The system is jointly financed by individuals, collectives, and the government and attempts to reduce illness-induced poverty and reimburse the cost of major illnesses.[15] Excepting Hong Kong and Macao, it covers all 22 provinces, 4 municipalities, and 5 autonomous regions in China. A total of 832 million rural residents (96% of the entire rural population of China) were covered by this system as of 2011.[16] The Chronic Disease Record was started in 2009 and includes demographic information, family history, medical history, outpatient record, and other information for every resident (as recorded by community medical centers). In 2011, it included 30% of rural residents nationwide.[17] All these policies and programs are important in preventing and controlling chronic diseases in rural areas.

Because the epidemiologic patterns of CVD change quickly in Chinese rural areas, we analyzed (1) CVD trends in rural populations, (2) awareness, treatment, and control of CVD, and their contributing factors, (3) the burden of chronic diseases, and local health needs, (4) medications commonly used for treating chronic diseases and their long-term beneficial effects, adverse effects, compliance, and pharmacoeconomics, and (5) effective preventive and control strategies that were specially developed for rural populations. These data will be useful in devising health policies to address the epidemic of CVD.

## METHODS

The main reason for developing the Fangshan cohort study was to analyze the changing epidemiologic characteristics of CVD among rural populations, including morbidity, mortality, prevalence, and risk factors. To investigate awareness, treatment, and control of CVD, we will conduct repeat surveys of medical history and medication adherence, as measured by the Morisky Scale.[18] The burden of chronic disease will be measured by potential years of life lost (PYLL),[19] disability-adjusted life years (DALYs),[20] and the

medical cost of the disease. Our ultimate goal is to collect data that assist in the development of suitable preventive strategies. This will require identification of the risk factor profile and sensitive biomarkers for CVD, and the establishing of intervention priorities, after which effective, economical treatment methods can be specially developed for rural populations.

## Study design, setting, and participants

The prospective study started in 2008, and the targeted population was local rural residents aged 40 years or older living in the Fangshan district of Beijing, 12.5 miles southwest of downtown Beijing (Figure). People were excluded if they had a severe physical or mental disease that made them unable to answer the questionnaire or if they had a severe medical condition that made them unable to report to the survey location. Fangshan occupies an area of $2019 \, km^2$ and comprises mountains, hills, and plateaus. It includes 8 subdistricts, 14 towns, and 6 townlets (the smallest administrative unit in China, based on the Constitution Law of 1982). The census population was 870 000, the rural population was greater than 400 000, and the population is relatively stable. Fangshan district has a high prevalence of CVD.[21–23] Local government and residents are cooperative, and the present authors have been involved in the area for other research projects since 1981.

A stratified, multistage, cluster-sampling design was used in the present study. A random sample of 3 towns (Zhoukoudian, Dashiwo, and Qinglonghu) was selected to represent the 3 different topographical areas (mountain, hill, and plateau, respectively), because both health knowledge and the conditions of the residents differ among these areas. The 3 selected towns are located in the north, center, and south of Fangshan district (in ascending order of distance from downtown Beijing). As in previous preliminary studies, we used inference for a single proportion to calculate sample size[24] for the 3 towns, to detect regional differences in CVD prevalence.[23,25] In Fangshan district the prevalence of stroke was lower than the prevalences of hypertension, coronary heart disease, and diabetes mellitus, according to our preliminary studies.[23,25] Using inference for a single proportion to calculate sample size,[24] the absolute precision was set as 10 percentage points of the expected prevalence, and the confidence level was set as 95%. The expected prevalence of stroke was 4.9%, 4.8%, and 4.3% for people aged 40 years or older in Zhoukoudian, Dashiwo, and Qinglonghu, respectively, according to our pilot study. After calculating the sample size for each town, we used cluster sampling, with the village as the unit. We calculated the proportion of people that had to be sampled from the census population in each town. That proportion was almost equal to the proportion of the village that needed to be sampled from the town, because the census population of the village is nearly identical. After the calculation, 14, 10, and 18 villages
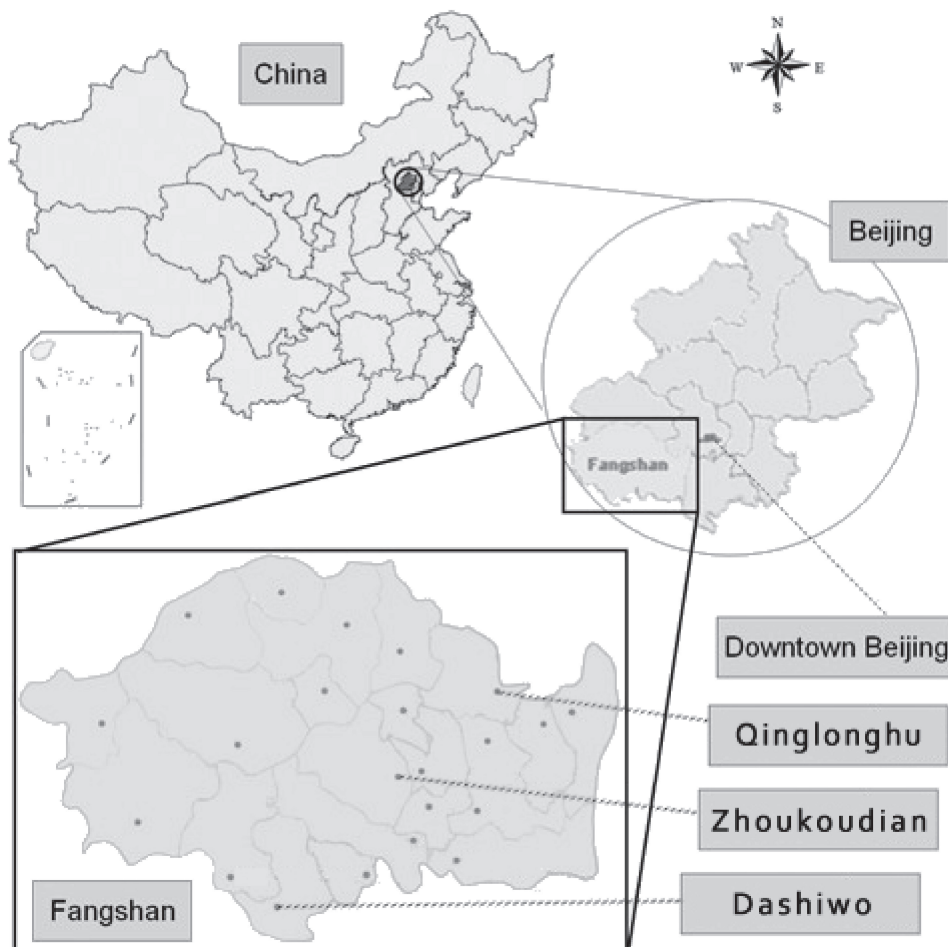
Figure.   Map showing the locations of the 3 towns studied in the Fangshan Cohort Study.

needed to be sampled out of the 24, 24, and 20 villages in Zhoukoudian, Dashiwo, and Qinglonghu, respectively. Within towns we used simple random cluster sampling for villages, because there is no heterogeneity of characteristics among different villages in the same town. In 2008, the annual per capita net income for rural residents (US dollars) was $1408 for Zhoukoudian, $1218 for Dashiwo, and $1254 for Qinglonghu. It ranged from $651 to $2446 for other areas and was $1450 for the Fangshan district overall.[26] Therefore, the economic levels of the 3 towns did not substantially differ from that of the Fangshan district overall and were higher than the national average for rural areas ($686 in 2008).

In 2008, the baseline survey was conducted for the sampling subjects ($n = 7514$) in Zhoukoudian town, which had a census population of 12 674 adults aged 40 years or older; 6047 chose to participate (participation rate = 80.5%). In 2009, the survey was conducted for the sampling subjects ($n = 7728$) in Dashiwo town, which had a census population of 17 872 adults aged 40 years or older; 6211 (80.4%) chose to participate. In 2010, the survey was conducted for the sampling subjects ($n = 8571$) in Qinglonghu town, which had a census population of 9753 adults aged 40 years or older; 7857 (91.7%) chose to participate. Thus, a total of 20 115

adults participated in the baseline survey of the 3 towns, and the overall participation rate was 84.5%.

The baseline survey included an interview and physical and blood biochemical examinations and was conducted at the community medical center of each sampled village. To recruit participants, the staffs of the local village governments publicized the survey through broadcasts and household telephone 1 day before and during the survey. The interview was done by trained investigators using a uniform questionnaire, the physical examination was conducted by research physicians and nurses, and the blood samples were processed by laboratory technicians.

**Baseline measures**

The main measures of the baseline examination are summarized in Table 1. Additional information for some items was investigated in the 2010 questionnaire survey.

The baseline questionnaire included the following individual-level information: demographic factors (age, sex, marriage status, education level, and occupation), medical history (year of diagnosis and medication used for hypertension, diabetes mellitus, coronary heart disease, and stroke diagnosed by a class 2 or higher hospital). To

**Table 1. Summary of the baseline measures in Fangshan Cohort Study**

Demographic information
    Age
    Sex
    Ethnic group
    Marital status
    Education background
    Occupation
    Annual income
Medical history
    Hypertension, diabetes mellitus, coronary heart disease, stroke
    Family history of hypertension, diabetes mellitus, coronary heart disease, stroke
Health knowledge and behaviors
    Willingness and methods to obtain health information
    Smoking status
    Alcohol consumption
    Physical exercise (frequency of exercise, type of exercise)
    Dietary pattern (preference for tea, meat, oil, sweet food, salty food)
    Sleep duration
Quality of life
    Assessed by self-rated health with 5 rating levels, or the EQ-5D scale[a]
Demand and utilization of health service[a]
Physical examination
    (Resting blood pressure, height, weight, waist and hip circumferences,[a] 12-lead resting electrocardiogram)
Blood biochemical examination
    Total cholesterol, triglycerides, HDL-cholesterol, LDL-cholesterol, blood glucose

Abbreviations: EQ-5D, European Quality of Life–5 Dimensions scale; LDL, low-density lipoprotein; HDL, high-density lipoprotein.
[a]Additional information investigated in 2010 questionnaire survey.

investigate genetic epidemiology, we also obtained a detailed family history of CVD so that we could collect information on pedigrees, sib-pairs, and twins. Investigated lifestyle factors included smoking status and number of cigarettes smoked per day (current smokers were defined as people who had smoked more than 100 cigarettes in the past and had smoked during the previous 30 days; ex-smokers were defined as people who had smoked more than 100 cigarettes in the past but had not smoked during the previous 30 days), drinking status (current drinkers were defined as persons who reported current consumption of alcohol at least once a week; ex-drinkers were defined as people who reported consuming alcohol at least once a week in the past but not during the previous 30 days), regular physical exercise (defined as intentional exercise for at least 30 minutes at least once per week during the previous 6 months, not including housework or job-related work), dietary pattern (preference for tea, meat, oil, sweet food, or salty food), and hours of sleep per night. The definition of smoking was the same as that used in the Chinese National Health Services Survey in 2008,[4] and the definitions for drinking and regular physical exercise were the same as those used in the Chinese National Health Services Survey in 2008 and National Nutrition and Health Survey in 2002.[4,27] Regular physical exercise was determined by asking the question, "Do you intentionally exercise?", and the responses "always"

(for at least 30 minutes ≥3 times per week) and "sometimes" (at least 30 minutes once or twice per week) were regarded as an affirmative response. Quality of life was assessed by the European Quality of Life–5 Dimensions (EQ-5D) scale[28] in 2010, and by self-rated health, with 5 rating levels, before that. Participant knowledge of CVD, and willingness and common approaches to obtain such knowledge, were also surveyed. We asked if they understood the relations between lifestyle and traditional risk factors and between risk factors and CVD. Further, we ascertained their willingness to obtain more information on healthy living, the media they most frequently consulted, and frequency of watching TV programs on the Fangshan Health Channel. We used some of the questions from the Chinese National Health Services Survey to measure resident health-service demands, utilization, and expenditure. Because the New Rural Cooperative Medical System was established in 2003, we also asked about participant satisfaction and comments regarding the system.

The physical examination comprised resting blood pressure, height, weight, waist circumference, hip circumference, and a 12-lead resting electrocardiogram (ECG). Systolic and fifth-phase diastolic blood pressures in the right arm were measured 3 times by trained physicians using standard mercury sphygmomanometers and a standard epidemiologic method. The participants were asked to sit and rest for 5 minutes before measurements.[29] Hypertension was defined as an average systolic blood pressure of 140 mm Hg or higher, an average diastolic blood pressure of 90 mm Hg or higher, and/or use of antihypertensive medications, according to the 1999 World Health Organization International Society of Hypertension Guidelines.[30] Diabetes mellitus was defined as a fasting glucose level of 7.0 mmol/l or higher, a random glucose level of 11.1 mmol/l or higher, and/or use of insulin or oral hypoglycemic agents, according to the 1999 World Health Organization Guidelines.[31] Height was measured by using a fixed stadiometer. Participants were asked to remove their shoes and hats, stand with heels, hips, and shoulders to the wall, look straight ahead, and keep their shoulders horizontal. The measurements were accurate to 1 cm. Weight was measured by a calibrated weighing scale. Participants were asked to remove heavy clothes and shoes. Measurements were accurate to 1 kg. Waist and hip circumferences were measured while the participant was standing. Waist circumference was measured with the tape at the midpoint between the lower costal margin and the iliac crest; hip circumference was measured at the level of maximal extension of the buttocks. The 12-lead resting ECG was measured by a standard method.[32]

Venous blood samples were sent to the laboratory of The First Hospital of Fangshan District for measurement of total cholesterol, triglycerides, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol (measured directly), and blood glucose. Serum was used for the assay, and blood samples were stored at −20°C for DNA extraction. The lipids

and glucose were analyzed by a Hitachi 7060 Automatic Biochemical Analyzer (Hitachi High-Technologies Corp., Tokyo, Japan). All samples were assayed in the same laboratory with the same analyzer. Quality control of the laboratory was maintained by internal standardization. In addition, the laboratory of the First Hospital of Fangshan District is under external standardization with the Beijing Central Clinical Laboratory.

### Follow-up and outcome measures

Follow-up surveys have been conducted every 2 years since 2010. The information collected is the same as that obtained for the baseline survey, except for family history. We also gathered information on outpatient records, to evaluate CVD treatment and control. This information was collected from community medical centers (which are present in every village). A morbidity and mortality surveillance system is currently under development. Fangshan joined the WHO-MONICA project in 1984,[33] and a registry system has been in place since then. The surveillance system is based on that registry system. The process and criteria for case ascertainment and validation are identical to those used in the WHO-MONICA project.[34] The surveillance system comprises the community medical centers, 3 township hospitals (each town has 1 township hospital), and 3 upper-class-2 hospitals (Liangxiang Hospital, the First Hospital of Fangshan District, and Fangshan Traditional Chinese Medicine Hospital).

### Ethical issues

The study protocol and informed consent procedure were approved by the Ethics Committees of Peking University Health Science Center. All study participants signed the informed consent form before taking part in the survey.

### Statistical analysis

Age- and sex-specific descriptive statistics are presented as mean (SD) for continuous variables and as frequency counts and proportions for categorical data. To test differences in means and proportions among the 3 towns, we used analysis of variance and the $\chi^2$ test, respectively. The Statistical Program for Social Sciences, Version 17.0 (SPSS Inc., Chicago, IL) was used for all statistical analyses. A 2-tailed $P$ value of less than 0.05 was considered to indicate statistical significance.

## RESULTS

Table 2 summaries the baseline characteristics of the participants. Mean age was 56.6 years for men and 55.6 years for women; 90.6% of men and 86.3% of women were married, and 7.0% of men and 12.8% of women were widowed. The proportion of married respondents decreased, and the proportion of widowed participants increased, with

increasing age. The proportion of single/divorced participants was 0.3% to 1.4% for both sexes. The most commonly reported level of education was junior high school (53.1% of men and 38.3% of women). A primary school education was the second most frequent level of education (22.8% of men and 28.2% of women). Few people had entered university (only 0.1% for both sexes). As age increased, the proportion of people who had never attended school increased and the proportions of those with a junior high school or high school education decreased.

Regarding smoking status, 57.1% of men and 11.1% of women were current smokers, and 26.9% of men and 85.8% of women were never smokers. As age increased, the proportion of current smokers decreased among men and increased among women.

As for alcohol consumption, 49.9% of men and 6.1% of women were current drinkers, and 38.7% of men and 92.8% of women were never drinkers. As age increased, the proportion of current drinkers decreased among men and increased among women, as was the case for smoking. Overall, 37.4% of men and 43.7% of women reported engaging in regular physical exercise. Excepting adults aged 80 years or older, the proportion of adults taking part in regular physical exercise increased with age.

Regarding dietary preference, 42.6% of men and 34.3% of women reported preferring salty foods. This preference was more prevalent among younger age groups in both sexes. The prevalence of hypertension was 64.5% among men and 61.8% among women. The prevalence of diabetes mellitus was 12.1% among men and 13.6% among women. The proportions of respondents who reported a diagnosis of hypertension, diabetes mellitus, coronary heart disease, and stroke were 43.8%, 11.9%, 14.5%, and 13.7%, respectively, among men and 47.2%, 14.5%, 19.6%, and 8.3%, respectively, among women.

Mean BMI was $25.4 \, \text{kg/m}^2$ among men and $26.5 \, \text{kg/m}^2$ among women; 43.6% of men and 47.0% of women were overweight (BMI $25.0–29.9 \, \text{kg/m}^2$) and 10.3% of men and 17.7% of women were obese (BMI $\geq 30.0 \, \text{kg/m}^2$). Mean BMI and the proportions of overweight and obesity were higher among younger as compared with older age groups.

All characteristics of the participants from the 3 towns significantly differed, except for prevalence of diabetes mellitus among men (Table 3). The men and women in Qinglonghu had higher educational levels, and lower proportions of current drinkers, as compared with participants in the other 2 towns. The men and women in Dashiwo had the lowest educational level and the lowest proportion of regular physical exercise.

## DISCUSSION

Fangshan is a rapidly urbanizing rural area and thus provides a good setting to investigate changes in cardiovascular risk

**Table 2.  Baseline characteristics of the Fangshan Cohort Study**

| Age, years | Men | | | | | | Women | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40–49 | 50–59 | 60–69 | 70–79 | ≥80 | Total | 40–49 | 50–59 | 60–69 | 70–79 | ≥80 | Total |
| Number | 1917 | 2463 | 1483 | 726 | 121 | 6710 | 4134 | 5118 | 2797 | 1172 | 184 | 13 405 |
| **Marital status (%)** | | | | | | | | | | | | |
| Single | 1.2 | 1.7 | 1.3 | 1.3 | 0.9 | 1.4 | 0.2 | 0.2 | 0.6 | 0.5 | 0.5 | 0.3 |
| Married | 96.3 | 94.0 | 90.0 | 71.2 | 52.2 | 90.6 | 97.4 | 93.4 | 77.5 | 47.1 | 25.5 | 86.3 |
| Divorced | 1.5 | 1.1 | 0.6 | 0.4 | 0 | 1.0 | 0.7 | 0.6 | 0.3 | 0.4 | 0.5 | 0.5 |
| Widowed | 1.0 | 3.1 | 8.1 | 27.0 | 47.0 | 7.0 | 1.7 | 5.8 | 21.7 | 52.1 | 72.6 | 12.8 |
| **Education (%)** | | | | | | | | | | | | |
| Never | 2.2 | 6.5 | 12.4 | 39.4 | 60.0 | 11.1 | 3.0 | 20.1 | 34.2 | 73.1 | 86.8 | 23.4 |
| Primary school | 7.5 | 21.8 | 31.9 | 47.2 | 26.1 | 22.8 | 12.2 | 35.8 | 41.7 | 22.5 | 10.4 | 28.2 |
| Junior high school | 65.4 | 59.2 | 50.8 | 11.8 | 10.4 | 53.1 | 64.8 | 34.7 | 23.0 | 3.5 | 2.7 | 38.3 |
| High school | 24.9 | 12.4 | 4.8 | 1.4 | 3.5 | 12.9 | 20.0 | 9.4 | 1.1 | 0.8 | 0 | 10.0 |
| University | 0 | 0 | 0.1 | 0.1 | 0 | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0.1 |
| **Smoking status (%)** | | | | | | | | | | | | |
| Never | 26.4 | 25.6 | 27.6 | 29.6 | 36.8 | 26.9 | 92.5 | 89.3 | 77.7 | 68.0 | 75.0 | 85.8 |
| Ex-smoker | 9.5 | 15.2 | 19.7 | 26.0 | 28.9 | 15.9 | 0.7 | 1.9 | 5.1 | 10.6 | 10.3 | 3.1 |
| Current | 64.0 | 59.2 | 52.7 | 44.4 | 34.2 | 57.1 | 6.8 | 8.8 | 17.1 | 21.4 | 14.7 | 11.1 |
| **Drinking status (%)** | | | | | | | | | | | | |
| Never | 37.5 | 38.4 | 38.4 | 43.3 | 44.7 | 38.7 | 93.5 | 93.8 | 92.1 | 88.7 | 88.5 | 92.8 |
| Ex-drinker | 6.9 | 11.4 | 12.8 | 18.7 | 18.4 | 11.3 | 0.5 | 0.8 | 1.6 | 3.5 | 1.6 | 1.1 |
| Current | 55.5 | 50.2 | 48.8 | 38.0 | 36.8 | 49.9 | 5.9 | 5.5 | 6.3 | 7.8 | 9.8 | 6.1 |
| **Regular physical exercise (%)[a]** | | | | | | | | | | | | |
| No | 71.0 | 64.8 | 54.6 | 49.9 | 51.8 | 62.6 | 62.4 | 57.7 | 47.8 | 47.5 | 62.7 | 56.3 |
| Yes | 29.0 | 35.2 | 45.4 | 50.1 | 48.2 | 37.4 | 37.6 | 42.3 | 52.2 | 52.5 | 37.3 | 43.7 |
| **Taste preference (%)** | | | | | | | | | | | | |
| Salty | 45.2 | 44.7 | 40.9 | 33.9 | 35.4 | 42.6 | 37.1 | 35.6 | 31.6 | 27.7 | 18.5 | 34.3 |
| Somewhat salty | 36.7 | 36.8 | 34.3 | 40.4 | 27.4 | 36.5 | 39.5 | 39.8 | 40.7 | 42.5 | 46.7 | 40.2 |
| Not salty | 18.1 | 18.4 | 24.9 | 25.7 | 37.2 | 20.9 | 23.5 | 24.7 | 27.7 | 29.7 | 34.8 | 25.5 |
| **Prevalence (%)** | | | | | | | | | | | | |
| Hypertension[b] | 58.7 | 63.9 | 68.5 | 73.3 | 69.3 | 64.5 | 51.6 | 61.5 | 70.3 | 76.8 | 73.1 | 61.8 |
| Diabetes mellitus[c] | 10.8 | 13.3 | 12.2 | 12.1 | 8.3 | 12.1 | 8.4 | 14.5 | 19.1 | 14.8 | 14.2 | 13.6 |
| **Medical history (%)** | | | | | | | | | | | | |
| Hypertension | 34.2 | 41.9 | 53.0 | 55.6 | 49.1 | 43.8 | 33.4 | 47.9 | 57.7 | 64.2 | 61.2 | 47.2 |
| Diabetes mellitus | 10.6 | 13.2 | 11.8 | 11.3 | 7.8 | 11.9 | 8.6 | 15.5 | 20.7 | 15.5 | 15.3 | 14.5 |
| Coronary heart disease | 7.5 | 12.6 | 21.3 | 24.9 | 17.1 | 14.5 | 8.2 | 18.0 | 30.3 | 37.5 | 37.2 | 19.6 |
| Stroke | 5.0 | 13.0 | 20.9 | 23.5 | 16.4 | 13.7 | 2.7 | 7.6 | 14.2 | 15.5 | 14.2 | 8.3 |
| BMI (kg/m$^2$) | 26.2 ± 3.6 | 25.5 ± 3.4 | 24.9 ± 3.4 | 24.1 ± 3.7 | 23.8 ± 3.8 | 25.4 ± 3.6 | 26.6 ± 3.7 | 26.8 ± 3.8 | 26.4 ± 4.0 | 25.4 ± 4.2 | 24.4 ± 3.9 | 26.5 ± 3.9 |
| **BMI (%)** | | | | | | | | | | | | |
| <18.5 | 0.7 | 1.2 | 2.3 | 4.1 | 5.8 | 1.7 | 0.3 | 0.6 | 1.5 | 3.9 | 5.0 | 1.1 |
| 18.5–24.9 | 35.7 | 42.9 | 50.4 | 57.9 | 61.7 | 44.5 | 34.3 | 30.9 | 35.7 | 42.5 | 50.9 | 34.2 |
| 25–29.9 | 49.6 | 45.6 | 39.9 | 31.5 | 26.7 | 43.6 | 48.0 | 49.3 | 44.9 | 39.4 | 37.9 | 47.0 |
| ≥30 | 14.1 | 10.4 | 7.4 | 6.6 | 5.8 | 10.3 | 17.3 | 19.1 | 17.9 | 14.3 | 6.2 | 17.7 |

Abbreviation: BMI, body mass index.
[a]Defined as intentional exercise for ≥30 minutes and at least once per week during previous 6 months, not including housework or job-related work.
[b]Defined as average systolic blood pressure ≥140 mm Hg, average diastolic blood pressure ≥90 mm Hg, and/or use of antihypertensive medications.
[c]Defined as fasting glucose ≥ 7.0 mmol/l, random glucose ≥ 11.1 mmol/l, and/or use of insulin or oral hypoglycemic agents.

factors and disease among rural populations in such conditions. Previous large cohort studies include the China Multi-provincial Cohort Study of 28 594 residents in 11 provinces (started in 1992; 12-year follow-up),[11] a prospective study of 5137 male steel workers in Beijing (21-year follow-up),[13] the USA-PRC collaborative study of 11 336 men and women in Beijing and Guangzhou (17-year follow-up),[12] and the Sino-MONICA project investigation of 5 million people in 16 provinces (7-year follow-up), which monitored trends and determinants of CVD.[7] However, all these studies ended

around the year 2000. The Fangshan Cohort Study will provide data on current cardiovascular epidemiology.

A limitation of the Fangshan Cohort study is the representativeness of the Chinese rural population. China is a large country, with great diversity among its different regions. There may be large differences in CVD incidence, prevalence, and mortality among different rural areas.[35] Nevertheless, the Fangshan district is representative of developed rural areas in northern China. Because the examinations were free, and due to the good relationship

**Table 3.  Baseline characteristics by town (*n*, [%])**

| | Men | | | P for difference | Women | | | P for difference |
|---|---|---|---|---|---|---|---|---|
| | Zhoukoudian | Dashiwo | Qinglonghu | | Zhoukoudian | Dashiwo | Qinglonghu | |
| Age (mean ± SD) | 55.6 ± 10.0 | 57.6 ± 17.8 | 56.5 ± 10.0 | <0.001 | 55.4 ± 10.0 | 55.6 ± 9.8 | 55.8 ± 9.6 | 0.110 |
| Age groups | | | | <0.001 | | | | <0.001 |
| 40–49 | 618 (31.8) | 520 (26.1) | 779 (28.1) | | 1305 (31.8) | 1304 (30.9) | 1525 (30.0) | |
| 50–59 | 736 (37.8) | 706 (35.4) | 1021 (36.9) | | 1597 (38.9) | 1599 (37.9) | 1922 (37.8) | |
| 60–69 | 376 (19.3) | 484 (24.2) | 623 (22.5) | | 746 (18.2) | 888 (21.1) | 1163 (22.9) | |
| 70–79 | 184 (9.5) | 249 (12.5) | 293 (10.6) | | 406 (9.9) | 365 (8.7) | 401 (7.9) | |
| ≥80 | 32 (1.6) | 37 (1.9) | 52 (1.9) | | 47 (1.1) | 59 (1.4) | 78 (1.5) | |
| Marital status | | | | <0.001 | | | | 0.001 |
| Single | 12 (0.7) | 42 (2.1) | 37 (1.4) | | 18 (0.5) | 5 (0.1) | 17 (0.3) | |
| Married | 1543 (92.5) | 1827 (89.6) | 2459 (90.1) | | 2985 (85.0) | 3747 (87.5) | 4373 (86.2) | |
| Divorced | 16 (1.0) | 12 (0.6) | 38 (1.4) | | 16 (0.5) | 17 (0.4) | 36 (0.7) | |
| Widowed | 96 (5.8) | 157 (7.7) | 195 (7.1) | | 494 (14.1) | 513 (12.0) | 645 (12.7) | |
| Education | | | | <0.001 | | | | <0.001 |
| Never | 172 (10.3) | 380 (18.6) | 160 (5.9) | | 783 (22.3) | 1502 (35.1) | 731 (14.4) | |
| Primary school | 358 (21.4) | 527 (25.9) | 583 (21.4) | | 1019 (29.0) | 1110 (25.9) | 1504 (29.7) | |
| Junior high school | 885 (53.0) | 937 (46.0) | 1597 (58.6) | | 1368 (38.9) | 1362 (31.8) | 2195 (43.3) | |
| High school | 244 (14.6) | 189 (9.3) | 382 (14.0) | | 346 (9.8) | 304 (7.1) | 635 (12.6) | |
| University | 12 (0.7) | 5 (0.2) | 4 (0.1) | | 2 (0.1) | 4 (0.0) | 1 (0.0) | |
| Smoking status | | | | 0.003 | | | | <0.001 |
| Never | 500 (29.6) | 507 (24.9) | 725 (26.8) | | 2920 (82.3) | 3756 (87.7) | 4367 (86.6) | |
| Ex-smoker | 288 (17.1) | 323 (15.8) | 414 (15.3) | | 156 (4.4) | 97 (2.3) | 144 (2.9) | |
| Current | 900 (53.3) | 1208 (59.3) | 1562 (57.8) | | 470 (13.3) | 431 (10.1) | 531 (10.5) | |
| Drinking status | | | | <0.001 | | | | <0.001 |
| Never | 689 (40.8) | 573 (28.1) | 1229 (45.5) | | 3205 (90.2) | 3927 (91.7) | 4822 (95.6) | |
| Ex-drinker | 185 (11.0) | 289 (14.2) | 253 (9.4) | | 66 (1.9) | 51 (1.2) | 29 (0.6) | |
| Current | 815 (48.3) | 1176 (57.7) | 1220 (45.2) | | 281 (7.9) | 306 (7.1) | 193 (3.8) | |
| Regular physical exercise[a] | | | | <0.001 | | | | <0.001 |
| No | 743 (45.1) | 1635 (80.2) | 1636 (59.9) | | 1347 (38.7) | 3148 (73.5) | 2741 (54.0) | |
| Yes | 905 (54.9) | 403 (19.8) | 1094 (40.1) | | 2133 (61.3) | 1135 (26.5) | 2338 (46.0) | |
| Taste preference | | | | <0.001 | | | | <0.001 |
| Salty | 716 (42.5) | 751 (36.8) | 1270 (47.1) | | 1213 (34.3) | 1303 (30.4) | 1894 (37.6) | |
| Somewhat salty | 610 (36.2) | 839 (41.2) | 892 (33.1) | | 1398 (39.5) | 1823 (42.6) | 1943 (38.6) | |
| Not salty | 358 (21.3) | 448 (22.0) | 536 (19.9) | | 929 (26.2) | 1158 (27.0) | 1197 (23.8) | |
| Prevalence | | | | | | | | |
| Hypertension[b] | 1362 (78.5) | 1539 (67.5) | 1427 (53.0) | <0.001 | 2561 (72.7) | 3258 (65.6) | 2465 (49.9) | <0.001 |
| Diabetes mellitus[c] | 224 (12.9) | 251 (11.0) | 331 (12.3) | 0.155 | 451 (12.8) | 621 (12.5) | 736 (14.9) | 0.001 |
| Medical history | | | | | | | | |
| Hypertension | 864 (50.0) | 852 (42.7) | 1104 (40.7) | <0.001 | 1787 (49.5) | 2004 (47.5) | 2285 (45.3) | <0.001 |
| Diabetes mellitus | 236 (13.6) | 187 (9.4) | 339 (12.6) | <0.001 | 499 (13.8) | 573 (13.6) | 788 (15.7) | <0.001 |
| Coronary heart disease | 279 (16.1) | 331 (16.6) | 320 (11.9) | <0.001 | 757 (21.0) | 812 (19.3) | 957 (19.0) | <0.001 |
| Stroke | 154 (8.9) | 315 (15.8) | 411 (15.2) | <0.001 | 192 (5.3) | 369 (8.8) | 504 (10.0) | <0.001 |
| BMI | 25.7 ± 3.3 | 25.2 ± 3.7 | 25.4 ± 3.6 | <0.001 | 26.5 ± 3.8 | 26.8 ± 3.8 | 26.2 ± 3.9 | <0.001 |
| BMI group | | | | <0.001 | | | | <0.001 |
| <18.5 | 22 (1.4) | 36 (1.5) | 55 (2.1) | | 37 (1.0) | 39 (0.8) | 63 (1.3) | |
| 18.5–24.9 | 631 (38.9) | 1172 (49.0) | 1168 (43.8) | | 1201 (33.8) | 1466 (31.5) | 1811 (37.0) | |
| 25–29.9 | 805 (49.6) | 946 (39.5) | 1160 (43.5) | | 1685 (47.5) | 2232 (47.9) | 2238 (45.8) | |
| ≥30 | 166 (10.2) | 240 (10.0) | 281 (10.5) | | 626 (17.6) | 919 (19.7) | 776 (15.9) | |

Abbreviation: BMI, body mass index.
[a]Defined as intentional exercise for ≥30 minutes and at least once per week during previous 6 months, not including housework or job-related work.
[b]Defined as average systolic blood pressure ≥140 mm Hg, average diastolic blood pressure ≥90 mm Hg, and/or use of antihypertensive medications.
[c]Defined as fasting glucose ≥7.0 mmol/l, random glucose ≥11.1 mmol/l, and/or use of insulin or oral hypoglycemic agent.

between the city government and our university, the participation rate was high. Therefore, potential bias due to nonparticipation is unlikely to be a concern.

Regarding resident characteristics, most participants were married. In addition 10% to 13% of participants had been in high school or university, which was lower than the 2010 national level in the same age group (17.1%).[36] The proportion of current smokers was 57.1% among men and 11.1% among women, which was similar to the 2008 national prevalence (about 58%) among men aged 40 years or older but higher than the national prevalence (3%) among women.[37] Fangshan had a higher prevalence of smoking than did rural communities in Japan (53% among men and 3% among women aged 40 to 69 years in 2003[38]). Unlike the trend toward higher smoking prevalence with increasing age among women in China,[39] prevalence was higher among young women than among elderly women in Japan. Also, among Japanese women aged 20 to 29 years, the prevalence of smoking increased from 7% in 1965 to 15% in 2008.[40] In contrast, among Chinese women in the same age group the prevalence of smoking decreased slightly from 1.2% in 1996 to 1.0% in 2002.[41]

Overall, 49.9% of men and 6.1% of women in our survey were current drinkers. As compared with 2002 national levels (43.3% and 6.8%, respectively, for age $\geq 40$ years[42]), the prevalence was higher for men and similar for women.

Overweight/obesity appears to be a serious public health issue in Fangshan. Average BMI was 25.4 kg/m$^2$ among men and 26.5 kg/m$^2$ among women, and the prevalence of overweight/obesity was 53.3% among men and 64.7% among women. These values are much higher than the 2002 national levels (25.2% and 29.2% for age $\geq 45$ years).[43] The prevalences of overweight/obesity in the rural districts of Beijing have been among the nation's highest since the 1980s.[44] Differences between rural areas of Beijing and other provinces in the prevalence of overweight/obesity have not diminished.[44] Overweight and obesity have traditionally been uncommon among Asians such as the Chinese and Japanese. However, the prevalence of overweight/obesity was much higher in Fangshan than in a rural area of Japan, which had an average BMI of 24.0 kg/m$^2$ among men and 24.3 kg/m$^2$ among women aged 40 years or older.[38] According to the 2009 National Health and Nutrition Survey in Japan, among adults aged 40 years or older the proportions of overweight and obesity were 27.6% and 3.4%, respectively, among men and 19.5% and 3.8% among women.[45] The 2008 NHANES in the United States showed that median BMI was 28.3 kg/m$^2$ among men and 27.7 kg/m$^2$ among women aged 40 years or older. Among adults aged 40 years or older the prevalences of overweight and obesity were 42.3% and 35.8%, respectively, among men and 31.7% and 35.8% among women.[46] Average BMI and the prevalence of overweight/obesity among Fangshan residents were between national levels in Japan and the United States.[45,46]

The high prevalence of overweight/obesity in Fangshan is likely mainly due to decreased activity thermogenesis. According to nutrition surveys done in Fangshan, mean daily energy intake changed from 2368 kcal in 1983 to 2576 kcal in 1992 to 2370 kcal in 1999, which indicates the lack of a marked change over time.[47,48] As for exercise activity, 37.4% of men and 43.7% of women in Fangshan reported taking part in regular physical exercise, similar to 2002 national prevalences for the same age group.[27] Therefore, a decrease in non-exercise activity, along with rapid economic development, may have contributed to the high prevalence of overweight/obesity in Fangshan. In a previous survey of 885 men and 646 women in rural Beijing, 60.0% of men and 52.8% of women reported that their occupational physical activity had decreased during the past 10 years.[49] Private business owners were most likely to report decreased occupational physical activity, probably because 27.1% of them had previously been peasants and 35.3% had been manual workers in national factories. Moreover, 52.6% of manual workers who did not change jobs reported decreased occupational physical activity, due to mechanization.[49] Although no research has studied leisure-time non-exercise activity in rural Beijing, the proportion of Chinese households with TV sets increased from 65% in 1989 to 91% in 1997,[50] and the increase was more evident in rural areas.[51]

The prevalence of hypertension was 64.5% among men and 61.8% among women in our study. These prevalences were much higher than those in the national data and other areas in China, using the same definition as that in the present study.[52,53] The InterASIA study of a nationally representative sample, conducted in 2000–2001, reported that hypertension prevalence was 28.6% among men and 25.8% among women aged 35 years or older.[52] Hypertension prevalence was 35.3% among men and 32.7% among women aged 35 years or older in rural areas of Shanghai in 2004.[53]

The prevalence of diabetes mellitus was 12.1% among men and 13.6% among women in Fangshan, which were also higher than national levels (ie, 4.6% among men and 5.4% among women aged 35–74 years in all rural areas of China in 2001, using the present definition[54]).

In Fangshan, 14.5% of men and 19.6% of women aged 40 years or older reported that they had received a diagnosis of coronary heart disease, and 13.7% of men and 8.3% of women had received a diagnosis of stroke. These percentages were much higher than national levels (1.0% of men and 0.7% of women aged $\geq 35$ years in rural populations of Linyi city for coronary heart disease,[55] 1.3% of men and 0.8% of women aged $\geq 40$ years for stroke nationally[56]). Our findings are consistent with previous results, which showed that Beijing has had the highest incidence and prevalence of coronary heart disease and stroke since 1987.[56,57] In 1987, the incidence of coronary heart disease in Beijing was 70.3/100 000 among men and 31.3/100 000 among women. Anhui and Sichuan provinces had the lowest incidence: 3.3/100 000 among men

in Anhui province and 1.3/100 000 among women in Sichuan province.[57] The prevalence of stroke in Beijing was 6.8% in 1991, while the lowest prevalence (1.2%) was in Henan province.[56] It is possible that Fangshan residents were more likely to report a medical history of coronary heart disease and stroke because, under the conditions of a policy established in Fangshan in 2008, they could receive free medications once diagnosed. Our surveillance of CVD incidence is expected to reveal a clearer picture of CVD in Fangshan.

In conclusion, the Fangshan Cohort Study will collect useful epidemiologic data on cardiovascular risk factors and disease profile, which will aid in the development of appropriate CVD prevention and control strategies for rural areas of China.

## ACKNOWLEDGMENTS

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