

## Serum Total and Lipoprotein Cholesterol Levels and Awareness, Treatment, and Control of Hypercholesterolemia in China

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**Background**—Cardiovascular disease has become the leading cause of death in China. We examined the levels of serum total and lipoprotein cholesterol and status of awareness, treatment, and control of hypercholesterolemia in China.

**Methods and Results**—A cross-sectional survey in a nationally representative sample of 15 540 Chinese adults 35 to 74 years of age was conducted during 2000 to 2001. Serum cholesterol was measured by use of standard methods, and information on treatment of hyperlipidemia was obtained by use of a standard questionnaire. Age-standardized mean levels of total, HDL, and LDL cholesterol and triglycerides were 186.1, 51.7, 109.5, and 128.1 mg/dL, respectively. Of the Chinese population 35 to 74 years of age, 23.8% (112 500 000 persons) had borderline high total cholesterol (200 to 239 mg/dL), and 9.0% (42 540 000 persons) had high total cholesterol ( $\geq 240$  mg/dL). The population estimates for borderline high (130 to 159 mg/dL), high (160 to 189 mg/dL), and very high ( $\geq 190$  mg/dL) LDL cholesterol were 17.0% (80 122 000 persons), 5.1% (24 329 000 persons), and 2.7% (12 822 000 persons), respectively. In addition, 19.2%, or 90 803 000 persons, had a low HDL cholesterol ( $< 40$  mg/dL). Among those who had a total cholesterol  $\geq 200$  mg/dL or who were on cholesterol-lowering medications, the proportion of men and women who were aware, treated, and controlled was only 8.8% and 7.5%, 3.5% and 3.4%, and 1.9% and 1.5%, respectively.

**Conclusions**—The prevalence of hypercholesterolemia was relatively high and the percentage of adults with controlled blood cholesterol was low in China. Prevention and treatment of hypercholesterolemia should be an important component of a national strategy to reduce the substantial and increasing burden of cardiovascular disease in China. (*Circulation*. 2004;110:405-411.)

**Key Words:** hypercholesterolemia ■ prevalence ■ awareness ■ cross-sectional studies ■ China

Cardiovascular disease (CVD) is a major cause of morbidity and a leading contributor to mortality worldwide.<sup>1</sup> Although CVD mortality has declined in economically developed countries, the emergence of a CVD epidemic has been observed in developing countries during recent decades.<sup>2</sup> The absolute burden of CVD mortality is high in economically developing countries, and much of this burden in developing countries occurs in China.<sup>1</sup> Over the next 20 years, CVD morbidity and mortality in China is projected to increase both in absolute number and as a proportion of total disease burden.<sup>3</sup> The epidemic of CVD in economically developing countries has resulted, in large part, from the economic growth and associated sociodemographic change that has occurred over recent decades. During this period, the burden of illness from infectious disease has fallen, but changes in lifestyle and diet have led to an increase in life expectancy and a greatly increased burden of CVD and other chronic diseases.<sup>2,4,5</sup>

High blood cholesterol is one of the most important modifiable risk factors for CVD in western<sup>6,7</sup> as well as in Asian<sup>8,9</sup> populations. However, there are sparse data on population levels of serum cholesterol in developing countries.<sup>10-13</sup> The objectives of the present study were (1) to provide current and reliable data on population levels of total and lipoprotein cholesterol levels in the general adult population in China and (2) to estimate the prevalence, awareness, treatment, and control of hypercholesterolemia in the general adult population in China.

### Methods

#### Study Population

The International Collaborative Study of Cardiovascular Disease in Asia (InterASIA) was a cross-sectional study of CVD risk factors conducted during 2000 to 2001 in China and Thailand. The InterASIA study used a 4-stage stratified sampling method to select a nationally representative sample of the general population 35 to 74

Received November 10, 2003; revision received March 18, 2004; accepted March 24, 2004.

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*Circulation* is available at <http://www.circulationaha.org>

DOI: 10.1161/01.CIR.0000136583.52681.0D



**Figure 1.** Map of China with study sites (north China: Jilin, Beijing, Qinghai, Shanxi, and Shandong; south China: Sichuan, Hubei, Shanghai, Fujian, and Guangxi).

years of age in China. The sampling process was stratified by rural versus urban areas and north versus south. The final stage of sampling was stratified by sex and by age distribution based on 1990 China Census data. Only 1 participant was selected from each household, without replacement. The study areas are shown in Figure 1.

A total of 19 012 persons were randomly selected from 20 primary sampling units (street districts in urban areas or townships in rural areas) and invited to participate. A total of 15 838 persons (7684 men and 8154 women) completed the survey and examination. The overall response rate was 83.3% (82.1% in men and 84.5% in women; 82.2% in urban and 84.4% in rural areas). The analysis reported in this article was restricted to the 15 540 adults who were 35 to 74 years of age at the time of the survey and had a serum cholesterol measurement.

### Measurements

Data collection was conducted in examination centers at local health stations or community clinics in the participants' residential area. In a few instances, participants were unable to attend the examination center, and the interview and examination were conducted in their home. During the clinic or home visits, trained research staff administered a standard questionnaire including questions related to the diagnosis and treatment of high blood cholesterol. Information on the awareness of, pharmaceutical treatment of, lifestyle modification for, and complementary/alternative medicine for hypercholesterolemia was also obtained.

Overnight fasting blood samples were drawn by venipuncture to measure serum total cholesterol, HDL cholesterol, and triglycerides. Blood specimens were processed at the field center and shipped by air to the central clinical laboratory at the Department of Population Genetics at Fuwai Hospital of the Chinese Academy of Medical Sciences in Beijing, where the specimens were stored at  $-70^{\circ}\text{C}$  until laboratory assays could be performed. This laboratory participates in the Lipid Standardization Program of the US Centers for Disease Control and Prevention. Total cholesterol, HDL cholesterol, and triglycerides were analyzed enzymatically on a Hitachi 7060 Clinical Analyzer (Hitachi High-Technologies Corp) by use of commercial reagents.<sup>14</sup> Serum control pools were obtained from Solomon Park Research Laboratories. LDL cholesterol levels were calculated by use of the Friedewald equation for the participants who had triglyc-

eride levels  $<400$  mg/dL:  $\text{LDL cholesterol} = \text{total cholesterol} - \text{HDL cholesterol} - \text{triglycerides}/5$ .<sup>15</sup>

Serum total, LDL, and HDL cholesterol levels were classified on the basis of the Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (ATP III).<sup>16</sup> Awareness of high blood cholesterol was defined as self-report of any previous diagnosis of hypercholesterolemia by a healthcare professional among the population defined as having high blood cholesterol. Treatment of hypercholesterolemia was defined as use of pharmacological treatment to lower blood cholesterol during the previous 2 weeks. Participants were considered to have controlled total cholesterol concentrations if their total cholesterol was  $<200$  or  $<240$  mg/dL or to have controlled LDL cholesterol concentration if their LDL cholesterol was  $<130$  or  $<160$  mg/dL, depending on the cholesterol threshold used for analysis.

The Institutional Review Board at the Tulane University Health Sciences Center and ethics committees and other relevant regulatory bodies in China approved the InterASIA study. Informed consent was obtained from each participant before data collection.

### Statistical Analysis

Mean levels of total, LDL, and HDL cholesterol and triglycerides were determined for the overall population and by age group for men and women. Next, mean levels were determined for men and women by region (urban and rural and north and south, separately) after age standardization to the overall year 2000 population of China. The prevalence estimates of total, LDL, and HDL cholesterol categories were calculated for the overall population and by age group. In addition, prevalence estimates were calculated for men and women, for north and south, and for urban and rural areas separately after age standardization.

All calculations were weighted to represent the total Chinese adult population 35 to 74 years of age. The weights were calculated on the basis of the 2000 China Population Census data and InterASIA sampling scheme and took into account several features of the survey, including oversampling for specific age or geographic subgroups, nonresponse, and other demographic or geographic differences between the sample and the total population. Standard errors were calculated by a technique appropriate to the complex

**TABLE 1. Age-Specific and Age-Standardized Serum Total Cholesterol, Lipoprotein Cholesterol, and Triglyceride Levels in the Adult Population Age 35–74 Years in China, 2000–2001**

Population Group	Serum Cholesterol, mg/dL			Triglycerides, mg/dL
	Total	HDL	LDL	
Total	186.1 (0.4)	51.7 (0.2)	109.5 (0.3)	128.1 (0.9)
Men				
Age, y				
35–74	184.3 (0.6)	51.0 (0.2)	108.3 (0.5)	129.2 (1.4)
35–44	182.3 (0.9)	50.1 (0.4)	106.2 (0.8)	135.4 (2.4)
45–54	184.5 (1.1)	50.6 (0.4)	107.9 (1.0)	134.2 (2.9)
55–64	188.2 (1.2)	52.6 (0.5)	112.2 (1.2)	118.1 (2.2)
65–74	184.3 (1.5)	51.9 (0.6)	110.0 (1.3)	114.1 (3.4)
Region				
North	189.0 (0.8)	47.8 (0.3)	115.4 (0.7)	131.9 (2.0)
South	181.0 (0.7)	53.2 (0.3)	103.2 (0.6)	127.3 (1.9)
Urban	193.0 (0.7)	46.8 (0.2)	116.8 (0.6)	154.8 (2.3)
Rural	182.1 (0.7)	52.0 (0.3)	106.2 (0.6)	122.6 (1.7)
Women				
Age, y				
35–74	188.0 (0.6)	52.5 (0.3)	110.7 (0.5)	126.9 (1.2)
35–44	176.0 (0.8)	52.1 (0.3)	101.3 (0.7)	114.6 (1.7)
45–54	189.9 (1.0)	52.9 (0.4)	112.0 (0.9)	127.8 (2.3)
55–64	200.1 (1.3)	52.8 (0.5)	119.9 (1.2)	141.6 (3.4)
65–74	202.4 (1.9)	52.3 (1.4)	123.4 (1.8)	141.0 (3.8)
Region				
North	191.1 (0.9)	49.1 (0.2)	117.0 (0.8)	126.5 (1.6)
South	185.7 (0.7)	55.0 (0.4)	106.2 (0.6)	127.2 (1.8)
Urban	196.4 (0.7)	52.3 (0.2)	118.2 (0.6)	132.9 (1.6)
Rural	185.8 (0.7)	52.5 (0.3)	108.8 (0.6)	125.4 (1.5)

Standardized on the basis of the age distribution of the Chinese population in the 2000 census. Values are mean (SEM).

survey design. All data analyses were conducted by use of STATA 7.0 (Statistics/Data Analysis) software.

## Results

### Mean Serum Cholesterol Levels

Mean levels of total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides were 186.1, 51.7, 109.5, and 128.1 mg/dL, respectively, in the general Chinese population 35 to 74 years of age (Table 1). Overall, the age-standardized mean levels of total, HDL, and LDL cholesterol were slightly higher in women than in men, whereas the mean level of triglycerides was higher in men than in women. Total and LDL cholesterol levels increased with age until 65 years in men but increased continuously over the entire age range in women. Age-standardized mean levels of total and LDL cholesterol were significantly higher in residents living in north compared with south China and in urban compared with rural China for both men and women. The age-standardized mean HDL cholesterol level was higher in both men and women living in south compared with north China and was higher in men but not women living in rural compared with urban China. The age-standardized mean level of triglycer-

ides was higher in men living in north compared with south China and was higher in men and women living in urban compared with rural China.

### Prevalence of Hypercholesterolemia

The age-standardized prevalence of borderline high total cholesterol (200 to 239 mg/dL) and high total cholesterol ( $\geq 240$  mg/dL) was 23.8% and 9.0%, respectively (Table 2). This represents 112 500 000 Chinese adults 35 to 74 years of age with borderline high total cholesterol and 42 540 000 persons with high total cholesterol. The prevalence of borderline high and high total cholesterol was slightly more common in women than in men, in residents living in north compared with south China, and in urban compared with rural China.

The age-standardized prevalence of borderline high (130 to 159 mg/dL), high (160 to 189 mg/dL), and very high ( $\geq 190$  mg/dL) LDL cholesterol was 17.0%, 5.1%, and 2.7%, respectively, which represents 80 122 000 persons, 24 329 000 persons, and 12 822 000 persons, respectively, in the general adult Chinese population 35 to 74 years of age (Table 3). The prevalence of borderline high, high, and very high LDL

**TABLE 2. Age-Specific and Age-Standardized Percentage Distribution of Serum Total Cholesterol in the Adult Population Age 35–74 Years in China, 2000–2001**

Population Group	Serum Total Cholesterol, mg/dL		
	<200	200–239	≥240*
Total	67.2 (0.5)	23.8 (0.5)	9.0 (0.3)
Men			
Age, y			
35–74	68.6 (0.7)	23.5 (0.7)	7.9 (0.4)
35–44	69.7 (1.1)	22.9 (1.0)	7.4 (0.7)
45–54	69.3 (1.4)	23.1 (1.2)	7.5 (0.7)
55–64	64.2 (1.6)	26.2 (1.5)	9.6 (1.0)
65–74	69.7 (2.1)	22.7 (1.9)	7.5 (1.2)
Regions			
North	62.8 (1.1)	27.0 (1.0)	10.2 (0.7)
South	72.7 (0.9)	21.0 (0.9)	6.2 (0.5)
Urban	60.2 (0.9)	28.5 (0.8)	11.3 (0.6)
Rural	70.7 (0.9)	22.3 (0.8)	7.0 (0.5)
Women			
Age, y			
35–74	65.8 (0.7)	24.1 (0.6)	10.2 (0.5)
35–44	77.5 (1.0)	18.3 (0.9)	4.2 (0.5)
45–54	64.0 (1.4)	26.0 (1.2)	10.0 (0.8)
55–64	53.3 (1.7)	29.2 (1.5)	17.5 (1.3)
65–74	52.2 (2.3)	29.6 (2.0)	18.2 (1.8)
Region			
North	60.8 (1.1)	26.3 (1.0)	12.9 (0.8)
South	69.4 (0.9)	22.4 (0.8)	8.2 (0.5)
Urban	55.9 (0.9)	30.7 (0.8)	13.4 (0.6)
Rural	68.3 (0.9)	22.4 (0.8)	9.3 (0.6)

Standardized on the basis of the age distribution of the Chinese population in the 2000 census. Values are percentage (SEM).

\*Includes persons with a total cholesterol  $\geq 240$  mg/dL and/or persons on lipid-lowering medication.

cholesterol was slightly higher in women than in men, in residents living in north compared with south China, and in urban compared with rural China. In addition, the age-standardized prevalence of low HDL cholesterol (<40 mg/dL) was 19.2% in the general adult population 35 to 74 years of age in China, which represents 90 803 000 persons (Table 4). The age-standardized prevalence of low HDL cholesterol was higher in men (22.1%) than in women (16.2%) and in residents living in north compared with south China. The age-standardized prevalence of a low HDL cholesterol was higher in urban than in rural men. In contrast, it was higher in rural than in urban women.

### Awareness, Treatment, and Control of Hypercholesterolemia

Among all participants who had an elevated total cholesterol concentration ( $\geq 200$  mg/dL) or who reported using cholesterol-lowering medications, the proportion of those who were aware of their condition was 8.8% in men and 7.5% in women, the proportion of those who were treated was 3.5% in

men and 3.4% in women, and the proportion of those who had a total cholesterol concentration <200 mg/dL was 1.9% in men and 1.5% in women (Figure 2). At the total cholesterol concentration of  $\geq 240$  mg/dL, the proportion of aware, treated, and controlled individuals in men and women was 21.3% and 18.1%, 14.0% and 11.6%, and 11.3% and 9.5%, respectively.

Among all participants who had an elevated LDL cholesterol concentration ( $\geq 130$  mg/dL) or who reported using cholesterol-lowering medications, 10.2% and 8.9% of men and women, respectively, were aware of their condition, 4.7% and 4.6% of men and women, respectively, were treated, and 3.0% and 2.5% of men and women, respectively, had an LDL cholesterol concentration <130 mg/dL (Figure 3). At an LDL cholesterol concentration of  $\geq 160$  mg/dL, the proportion of aware, treated, and controlled individuals in men and women was 21.8% and 19.8%, 15.6% and 13.9%, 12.1% and 11.0%, respectively.

Among those who reported using cholesterol-lowering medications, the percentage of participants who controlled their total cholesterol concentration to <200 mg/dL was 53.9% in men and 43.8% in women. The corresponding estimates for control of total cholesterol to <240 mg/dL was 81.0% and 82.5% for men and women, respectively. Analogously, among those who reported using cholesterol-lowering medications, the percentage of participants who controlled their LDL cholesterol to <130 mg/dL was 62.4% in men and 53.7% in women and was 77.2% in men and 79.0% in women at a LDL cholesterol concentration <160 mg/dL.

### Nonpharmacological Interventions

Among all participants who had a borderline high or high total cholesterol level ( $\geq 200$  mg/dL) and were aware of this condition, 61.8% were engaged in a therapeutic lifestyle change, such as weight loss (36.3%), exercise (43.8%), or dietary fat and cholesterol reduction (56.6%). A slightly higher proportion of persons with LDL cholesterol  $\geq 130$  mg/dL were engaged in these therapeutic lifestyle changes (Table 5). In addition, 13.5% of persons with total cholesterol  $\geq 200$  mg/dL and 13.9% persons with LDL cholesterol  $\geq 130$  mg/dL currently used complementary/alternative treatments.

### Discussion

Our study indicates that the mean levels of total and LDL cholesterol and triglycerides in the general Chinese adult population are higher than previously reported from regional studies conducted in China.<sup>10,13</sup> Furthermore, our study suggests that 32.8% of the Chinese general population 35 to 74 years of age, or 155 040 000 persons, have borderline high or high total cholesterol ( $\geq 200$  mg/dL), whereas 24.8%, or 117 273 000 persons, in the same age range have a borderline high, high, or very high level of LDL cholesterol ( $\geq 130$  mg/dL). Among those who have elevated total or LDL cholesterol, the proportions of patients who are aware, treated, and controlled are extremely low. The present study documents a large and increasing burden of high blood cholesterol in the Chinese general population.

InterASIA is the first national study to examine the mean levels of total and lipoprotein cholesterol and to estimate the

**TABLE 3. Age-Specific and Age-Standardized Percentage Distribution of LDL Cholesterol in the Adult Population Age 35–74 Years in China, 2000–2001**

Population Group	Serum LDL Cholesterol, mg/dL				
	<100	100–129	130–159	160–189	≥190*
Total	42.0 (0.5)	33.2 (0.5)	17.0 (0.4)	5.1 (0.2)	2.7 (0.2)
Men					
Age, y					
35–74	42.9 (0.8)	33.5 (0.7)	16.4 (0.6)	4.9 (0.3)	2.3 (0.2)
35–44	46.5 (1.2)	32.1 (1.2)	15.1 (0.9)	4.5 (0.5)	1.8 (0.3)
45–54	42.5 (1.5)	34.8 (1.4)	15.4 (1.0)	4.8 (0.7)	2.4 (0.5)
55–64	38.4 (1.6)	32.3 (1.6)	20.1 (1.4)	6.3 (0.8)	3.0 (0.6)
65–74	39.1 (2.2)	36.8 (2.2)	17.6 (1.8)	4.2 (0.9)	2.2 (0.6)
Region					
North	33.5 (1.0)	34.3 (1.1)	21.3 (1.0)	7.1 (0.6)	3.8 (0.5)
South	49.5 (1.1)	33.0 (1.0)	12.9 (0.7)	3.4 (0.4)	1.2 (0.2)
Urban	31.1 (0.9)	37.0 (0.9)	20.8 (0.8)	7.8 (0.5)	3.2 (0.3)
Rural	45.8 (0.9)	32.7 (0.9)	15.3 (0.7)	4.2 (0.4)	2.0 (0.3)
Women					
Age, y					
35–74	41.0 (0.7)	32.9 (0.7)	17.5 (0.6)	5.4 (0.4)	3.2 (0.3)
35–44	52.4 (1.2)	31.7 (1.1)	11.8 (0.8)	2.9 (0.4)	1.2 (0.3)
45–54	37.9 (1.4)	33.7 (1.3)	20.7 (1.2)	4.8 (0.6)	2.8 (0.5)
55–64	30.8 (1.6)	34.6 (1.6)	20.3 (1.3)	9.0 (1.0)	5.3 (0.7)
65–74	28.6 (2.1)	32.0 (2.1)	23.1 (1.9)	9.2 (1.4)	7.0 (1.3)
Region					
North	32.7 (1.0)	33.0 (1.1)	21.6 (1.0)	7.3 (0.7)	5.3 (0.6)
South	47.1 (1.0)	32.7 (1.0)	14.5 (0.7)	4.0 (0.4)	1.6 (0.2)
Urban	30.7 (0.8)	35.8 (0.9)	21.4 (0.7)	7.6 (0.5)	4.5 (0.4)
Rural	43.7 (0.9)	32.1 (0.9)	16.6 (0.7)	4.8 (0.4)	2.8 (0.3)

Standardized on the basis of the age distribution of the Chinese population in the 2000 census. Values are percentage (SEM).

\*Includes persons with an LDL cholesterol  $\geq 190$  mg/dL and/or persons on a lipid-lowering medication.

prevalence, awareness, treatment, and control of hypercholesterolemia in the general adult population in China. This study was conducted in a large representative sample of the Chinese adult population in which a high response rate was achieved. Standard protocols and instruments along with strict training processes for data collection and a vigorous quality assurance program were used to ensure that the data we collected was of high quality. In addition, standard laboratory methods for the measurement of serum lipids were used, and a central clinical laboratory performed all of the lipid assays. For all these reasons, this study provides the most reliable and up-to-date information on the prevalence of hypercholesterolemia in the adult population in China.

Our findings have important public health implications. Traditionally, mortality from coronary heart disease in China has been infrequent and is estimated to be only  $\approx 0.1$  of that in Western populations.<sup>17</sup> A low serum total cholesterol level related to a low habitual dietary intake of fat and cholesterol is considered to be the main underlying reason for the low coronary heart disease mortality in China.<sup>18</sup> In the InterASIA study, we noted a relatively high mean level of serum

cholesterol but a low rate of hypercholesterolemia control. This might explain the recent rapid increase in coronary heart disease mortality in China. Furthermore, our results suggest that without a national emphasis on prevention, treatment, and control of hypercholesterolemia, the societal burden of CVD in China will continue to increase in the near future.

During the past several decades, the population level of serum cholesterol has declined in the US population.<sup>19,20</sup> For example, the mean level of total cholesterol declined from 220 to 205 mg/dL ( $-7\%$ ) between 1960 to 1962 and 1988 to 1991.<sup>19</sup> In addition, the mean level of LDL cholesterol declined from 136 to 128 mg/dL ( $-6\%$ ) between 1976 to 1980 and 1988 to 1991. Compared with the US population, the age-specific and age-standardized mean level of total and LDL cholesterol is still much lower in the Chinese population. The present study shows that mean HDL cholesterol levels in the Chinese and US populations were similar: 51.7 and 51.0 mg/dL, respectively.<sup>19</sup> In contrast to the pattern in the US population, we did not observe a large difference in HDL cholesterol levels in men and women in the Chinese population.

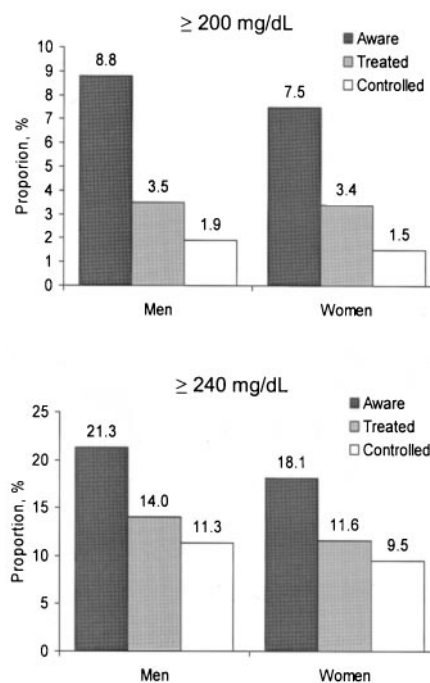
**TABLE 4. Age-Specific and Age-Standardized Percentage Distribution of Serum HDL Cholesterol in Adult Population Age 35–74 Years in China, 2000–2001**

Population Group	Serum HDL Cholesterol, mg/dL		
	<40	40–59	≥60
Total	19.2 (0.4)	56.6 (0.5)	24.1 (0.4)
Men			
Age, y			
35–74	22.1 (0.6)	55.1 (0.8)	22.8 (0.7)
35–44	22.9 (1.0)	56.9 (1.2)	20.2 (1.0)
45–54	22.9 (1.2)	55.5 (1.5)	21.6 (1.3)
55–64	21.0 (1.3)	50.6 (1.7)	28.4 (1.6)
65–74	19.3 (1.7)	55.5 (2.3)	25.2 (2.0)
Region			
North	27.3 (1.0)	57.4 (1.1)	15.3 (0.8)
South	18.4 (0.8)	53.5 (1.1)	28.1 (1.0)
Urban	29.5 (0.8)	57.2 (0.9)	13.3 (0.6)
Rural	20.2 (0.7)	54.6 (0.9)	25.2 (0.8)
Women			
Age, y			
35–74	16.2 (0.6)	58.2 (0.7)	25.6 (0.7)
35–44	15.6 (0.9)	59.5 (1.2)	24.9 (1.0)
45–54	14.8 (1.0)	58.2 (1.4)	27.0 (1.3)
55–64	16.1 (1.2)	58.1 (1.7)	25.9 (1.5)
65–74	21.5 (1.9)	54.4 (2.3)	24.1 (1.9)
Region			
North	21.1 (1.0)	63.2 (1.1)	15.7 (0.8)
South	12.6 (0.7)	54.5 (1.0)	32.9 (1.0)
Urban	14.6 (0.6)	61.2 (0.9)	24.2 (0.8)
Rural	16.5 (0.7)	57.5 (0.9)	25.9 (0.8)

Standardized on the basis of the age distribution of the Chinese population in the 2000 census. Values are percentage (SEM).

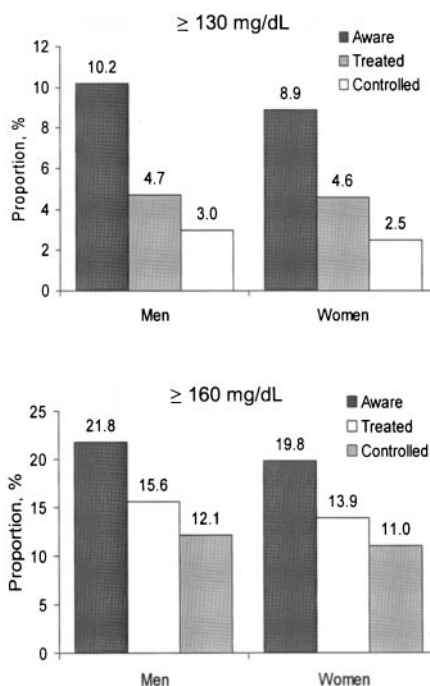
A few regional studies have examined serum cholesterol levels in Chinese populations.<sup>13,18</sup> The PRC-USA Collaborative Study in Cardiovascular and Cardiopulmonary Epidemiology, which was conducted in 4280 Chinese men and 4695 women 35 to 54 years of age in 1983 to 1984, reported that age-adjusted mean serum total cholesterol level was higher in urban than in rural samples and generally higher in Beijing than in Guangzhou.<sup>18</sup> In a repeated survey conducted in the same populations during 1993 to 1994, the mean total cholesterol level increased in Guangzhou but decreased in Beijing.<sup>13</sup> However, this study was conducted in an occupational population sample of convenience rather than in a representative sample of the general population. A rapid increase in total serum cholesterol level has also been observed in residents living in Shanghai, China.<sup>21</sup> The differences in dietary nutrient intake between north and south as well as between rural and urban China may contribute to the observed regional differences in serum lipid levels.<sup>22</sup>

Economic growth and associated changes in lifestyle and diet might contribute to the increase in serum cholesterol in the Chinese population. In the regions with fast economic growth, such as Guangzhou and Shanghai, the mean level of



**Figure 2.** Awareness, treatment, and control of high total cholesterol among Chinese adult population 35 to 74 years of age, 2000 to 2001.

serum cholesterol has increased dramatically.<sup>13,21</sup> For example, over a 10-year period the serum total cholesterol level for men and women in Guangzhou has increased 13.9% and 21.5% in urban areas and 18.9% and 24.9% in rural areas, respectively.<sup>13</sup> This increase is partially explained by obesity and a diet high in cholesterol and saturated fat.<sup>13</sup>



**Figure 3.** Awareness, treatment, and control of high LDL cholesterol among Chinese adult population 35 to 74 years of age, 2000 to 2001.

**TABLE 5. Percentage of the Adult Population Age 35–74 Years with a High Cholesterol and Awareness of This Condition Who Reported Current Use of Nonpharmacological or Complementary/Alternative Treatments Prescribed by a Health Professional for Treatment of Hypercholesterolemia in China, 2000–2001**

Treatment	Total Cholesterol ≥200 mg/dL	LDL Cholesterol ≥130 mg/dL
Weight loss	36.3 (3.0)	40.2 (3.3)
Exercise	43.8 (3.1)	46.8 (3.4)
Dietary fat/cholesterol reduction	56.6 (3.1)	59.8 (3.3)
Any of the above	61.8 (3.1)	65.5 (3.2)
Complementary/alternative treatments	13.5 (2.1)	13.9 (2.3)

Values are percentage (SEM).

The proportion of persons aware, treated, and controlled for total and LDL cholesterol among participants with hypercholesterolemia was extremely low in the Chinese population. The US National Health and Nutrition Examination Survey, 1999 to 2000, reported that among men and women who had a total serum cholesterol concentration  $\geq 200$  mg/dL or who reported using cholesterol-lowering medications, 34.8% and 35.4% were aware that they had hypercholesterolemia, 14.0% and 10.2% were on treatment, and 7.5% and 3.7% had a total cholesterol concentration  $< 200$  mg/dL, respectively.<sup>20</sup> By use of the same criteria, the proportion who were aware, treated, and controlled was only 8.8% and 7.5%, 3.5% and 3.4%, and 1.9% and 1.5%, in Chinese men and women, respectively.

This first national survey on serum cholesterol levels in China indicated that the mean serum total and LDL cholesterol levels were higher than previously reported from regional studies. Furthermore, awareness, treatment, and control rates of hypercholesterolemia in the Chinese population were extremely low. The prevention and treatment of hypercholesterolemia should become an important component of a national strategy to reduce the large and increasing burden of CVD in China.

### Acknowledgments

The InterASIA study was funded by a contractual agreement between Tulane University, New Orleans, La, and Pfizer Inc, New York, NY. Several researchers employed by Pfizer Inc were members of the Study Steering Committee that designed the study. However, the study was conducted, analyzed, and interpreted by the investigators independently of the sponsor.

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