

Blood Lipid Profile and Prevalence of Dyslipidemia in Chinese Adults

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Objective To investigate the plasma lipid levels in a national representative sample of subjects and to determine the prevalence of dyslipidemia in the Chinese population. **Methods** Plasma lipid profile was analyzed using the data obtained during the Chinese national nutrition and health survey (CNHS) in 2002 which involved 14 252 participants at the age of 18 years or older. **Results** The mean levels of total cholesterol (TC), triglyceride (TG) and high density lipoprotein cholesterol (HDL-C) in the participants were 3.81 mmol/L, 1.10 mmol/L, and 1.30 mmol/L, respectively. In the groups of participants at the age of 18-44 years, 45-59 years, and over 60 years the mean TC level was 3.70 mmol/L, 4.09 mmol/L and 4.21 mmol/L, respectively, and the mean TG level was 0.7 mmol/L, 1.21 mmol/L, 1.20 mmol/L, 1.29 mmol/L, 1.33 mmol/L, and 1.33 mmol/L, respectively. The prevalence of dyslipidemia in Chinese adults was 18.6% and 22.2% in males and 15.9% in females. Dyslipidemia prevalence was higher in urban districts than in rural areas (21.0% vs. 17.7%). The prevalence of hypercholesterolemia, hypertriglyceridemia, and low HDL cholesterol was 2.9%, 11.9%, and 7.4% respectively among the participants. **Conclusion** Dyslipidemia has become one of the important health risk factors in the Chinese population. There is no significant difference in the prevalence of dyslipidemia between the groups of participants at the age of 45-59 years and over 60 years. This study provides important lipid profile data for policy making and guideline development for the prevention of dyslipidemia in the Chinese population.

Key words: Chinese adults; Total cholesterol; Triglyceride; High density lipoprotein cholesterol; Dyslipidemia

INTRODUCTION

Lipid abnormalities are the leading risk factor for coronary heart diseases. In the 1980s and 1990s, several epidemiological studies on blood lipids were conducted in China, such as MONICA (1983-1993) and the cohort study of risk factors for cardiovascular diseases in 11 provinces in China^[1-2]. However, no representative nationwide survey was made on blood lipid profile and prevalence of dyslipidemia in the Chinese population. The lifestyle of the Chinese has been significantly changed in the past two decades^[3-9]. In 2002, Ministry of Health, Ministry of Science and Technology, and National Bureau of Statistics jointly conducted the "Chinese Nutrition and Health Survey (2002-CNHS)" to determine the recent dietary behaviors as well as nutrition and health status in the

Chinese population. This paper reports the blood lipid profile and prevalence of dyslipidemia in Chinese adults.

METHODS

Study Population and Sampling Method^[10]

2002 CNHS covered 31 provinces, autonomous regions and municipalities in China (excluding Hong Kong, Macao Special Administrative Regions, and Taiwan). The samples were geographically representative. The randomized multi-step cluster sampling method was used. A total of 132 counties/districts/cities (22 from each category: major, medium, and small cities, 4 rural areas from high to low development) were selected at the first phase of sampling. Three townships/ street councils were

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selected from each of selected counties/districts/cities at the second phase of sampling. Two village residents were selected from each township/street council at the third phase of sampling, and 90 households were selected from each village/resident council. Finally, 30 households were selected randomly from these 90 households. Dietary surveys were conducted and blood samples from each family member aged 3 years or above were taken for plasma lipid analysis. The aim of the study was explained in details to each family member. All the participants in the study gave their written formal consent.

Data Collection Instrument and Method^[10]

The survey was consisted of questionnaire, health examination, laboratory tests, and dietary survey. Plasma TC, TG, and HDL-C were measured with the enzymatic method using Hitachi 7060 and 7180 auto-analyzer (Hitachi, Tokyo, Japan) and Vital Selection auto-analyzer (Vital Selection, Netherlands) in the Department of Elderly and Clinical Nutrition, Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, and the Central Laboratory of Beijing Center for Disease Control and Prevention. A technician was trained for procedures of standardized analysis. Reagents of the same batch were used and purchased from Beijing Zhongsheng Reagents Company. All test indicators of blood lipid met the standard required by Centers for Disease Control, USA^[10].

The definition for dyslipidemia is as follows^[11]:

Hypercholesterolemia: TC \geq 5.72 mmol/L (220 mg/dL);

Borderline hypercholesterolemia: TC 5.20-5.71 mmol/L (201-219 mg/dL);

Hypertriglyceridemia: TG \geq 1.70 mmol/L (150 mg/dL);

Low HDL-cholesterolemia: HDL-C \leq 0.91 mmol/L (35 mg/dL);

Dyslipidemia: any of hypercholesterolemia or hypertriglyceridemia or low HDL-cholesterol.

Statistical Methods

The mean of blood lipid and the prevalence of dyslipidemia in all participants were calculated. The data were categorized into age (at the age of 18-44, 45-59, \geq 60 years), gender, and region groups. Age and region-specific adjustment was made for the mean of TC, TG and HDL-C and the prevalence of dyslipidemia based on the data collected in the 5th Chinese national census in 2000. Statistical procedures were performed with SAS (8.2 version, Inc. NC, USA).

RESULTS

General Information on the Subjects

The subjects included 49 252 adults (23 187 males accounting for 47.15%, and 26 065 females accounting for 52.9%). Sixteen thousand and eight hundred eighty-three participants were from urban districts and 32 369 from rural areas (Table 1).

TABLE 1

Distribution of Age, Gender, and Region in Chinese Adults

Age Groups (Years)	Total			Urban			Rural		
	Total	Male	Female	Sub-total	Male	Female	Sub-total	Male	Female
18-44	23930	11030	12900	8207	3686	4521	15723	7344	8379
45-59	16101	7523	8578	5520	2514	3006	10581	5009	5572
\geq 60	9221	4634	4587	3156	1549	1607	6065	3085	2980
Total	49252	23187	26065	16883	7749	9134	32369	15438	16931

Distribution of Mean TC, TG, and HDL-C

TC The adjusted mean TC was 3.81 mmol/L, 3.96 mmol/L in participants from urban districts and 3.75 mmol/L in participants from rural areas, respectively. In groups at the age of 18-44, 45-59, and over 60 years, the mean TC was 3.70 mmol/L, 4.09 mmol/L and 4.21 mmol/L, respectively. The level of TC increased with the increase of age. There was no significant difference in gender group (Table 2).

TG The adjusted mean plasma TG in

participants was 1.10 mmol/L, 1.16 mmol/L in urban districts and 1.07 mmol/L in rural areas, respectively. In groups at the age of 18-44, 45-59, and over 60 years, the value was 1.07 mmol/L, 1.21 mmol/L and 1.20 mmol/L, respectively. The results showed that the mean TG level in participants from urban districts was significantly higher than that in participants from rural areas. There was no significant difference between groups at the age of 45-59 and over 60 years, but the mean TG level was the lowest in the group at the age of 18-44 years (Table 3).

TABLE 2

Distribution of Adjusted Mean Plasma TC* in Chinese Adults (mmol/L)			
Age Group (Years)	Total	Urban	Rural
18-44	3.70	3.81	3.65
Male	3.77	3.89	3.71
Female	3.64	3.75	3.59
45-59	4.09	4.29	4.02
Male	4.03	4.21	3.96
Female	4.14	4.35	4.07
≥60	4.21	4.49	4.10
Male	4.06	4.32	3.96
Female	4.36	4.67	4.25
Total	3.81	3.96	3.75
Male	3.81	3.96	3.75
Female	3.82	3.96	3.76

Note. *Adjusted by age and region.

TABLE 3

Distribution of Adjusted Mean Plasma TG* in Chinese Adults (mmol/L)			
Age Group (Years)	Total	Urban	Rural
18-44	1.07	1.10	1.05
Male	1.20	1.30	1.15
Female	0.96	0.94	0.96
45-59	1.21	1.33	1.16
Male	1.20	1.40	1.13
Female	1.21	1.27	1.19
≥60	1.20	1.35	1.14
Male	1.11	1.27	1.05
Female	1.29	1.43	1.24
Total	1.10	1.16	1.07
Male	1.13	1.18	1.11
Female	1.05	1.06	1.05

Note. *Adjusted by age and region.

HDL-C The adjusted mean plasma HDL-C level was 1.30 mmol/L, 1.30 mmol/L in participants from urban districts, and 1.30 mmol/L in those from rural areas. In groups at the age of 18-44, 45-59, and over 60 years, the mean HDL-C level was 1.29 mmol/L, 1.33 mmol/L, and 1.33 mmol/L, respectively. The mean HDL-C level was significantly higher in females than in males in the same age groups (Table 4).

TABLE 4

Adjusted Mean Plasma HDL-C Level* in Chinese Adults (mmol/L)			
Age Group (Years)	Total	Urban	Rural
18-44	1.29	1.29	1.28
Male	1.25	1.22	1.26
Female	1.32	1.35	1.31
45-59	1.33	1.31	1.33
Male	1.31	1.25	1.34
Female	1.34	1.35	1.33
≥60	1.33	1.31	1.33
Male	1.31	1.27	1.33
Female	1.34	1.36	1.33
Total	1.30	1.30	1.30
Male	1.26	1.23	1.28
Female	1.33	1.36	1.31

Note. *Adjusted by age and region.

Prevalence of Dyslipidemia, Hypercholesterolemia, Hyperglyceridemia, and Low HDL-C

Dyslipidemia The overall adjusted prevalence of dyslipidemia was 18.6%, 22.2% in males, and 15.9% in females, respectively. In groups at the age of 18-44, 45-59, and ≥60 years, the prevalence of dyslipidemia was 17.0%, 22.9%, and 23.4%, respectively. The adjusted prevalence of dyslipidemia was 21.0% in participants from urban districts and 17.7% in those from rural areas, respectively. There was no significant difference in the prevalence of dyslipidemia between groups at the age of 45-59 and ≥60 years. The prevalence of dyslipidemia was significantly higher in participants from urban districts than in those from rural areas (Table 5).

Hypercholesterolemia The adjusted prevalence of hypercholesterolemia was 2.9%, 2.7% in males and 3.2% in females, respectively, 4.1% in participants from urban districts, 2.4% in those from rural areas. In groups at the age of 18-44, 45-59, and ≥60 years, hypercholesterolemia prevalence was 1.8%, 4.7% and 6.1%, respectively. The results showed that the higher prevalence was associated with increased age (Table 6).

Borderline hypercholesterolemia The adjusted prevalence of borderline hypercholesterolemia was 3.9% in adults, and no difference was found in gender group. In groups at the age of 18-44, 45-59, and ≥60 years, the adjusted prevalence of borderline hypercholesterolemia was 2.6%, 5.9%, and 6.2%, respectively. The prevalence of borderline hypercholesterolemia was 5.1% in participants from urban districts and 3.3% in those from rural areas, respectively (Table 7).

TABLE 5
Adjusted Prevalence of Dyslipidemia* in Chinese Adults (%)

Age Group (Years)	Total		Urban		Rural	
	Case	%	Case	%	Case	%
18-44	4216	17.0	1282	17.8	2934	16.6
Male	2598	23.3	886	27.4	1712	21.5
Female	1618	11.6	396	10.0	1222	12.4
45-59	3868	22.9	1560	29.0	2308	20.6
Male	1894	23.9	782	32.3	1112	20.7
Female	1974	22.1	778	26.3	1196	20.4
≥60	2350	23.4	1235	30.5	1115	20.8
Male	1031	20.4	548	27.6	483	17.8
Female	1319	26.4	687	33.5	632	23.8
Total	10434	18.6	4077	21.0	6357	17.7
Male	5523	22.2	2216	27.2	3307	20.1
Female	4911	15.9	1861	16.3	3050	15.7

Note. *Adjusted by age and region.

TABLE 6
Adjusted Prevalence of Hypercholesterolemia* in Chinese Adults (%)

Age Group (Years)	Total		Urban		Rural	
	Case	%	Case	%	Case	%
18-44	426	1.8	159	2.1	267	1.6
Male	246	2.3	87	2.7	159	2.2
Female	180	1.3	72	1.7	108	1.2
45-59	793	4.7	384	7.0	409	3.9
Male	298	4.0	140	6.0	158	3.2
Female	495	5.4	244	7.9	251	4.5
≥60	699	6.1	459	10.6	240	4.5
Male	225	4.0	143	7.0	82	2.9
Female	474	8.3	316	14.2	158	6.2
Total	1918	2.9	1002	4.1	916	2.4
Male	769	2.7	370	3.7	399	2.3
Female	1149	3.2	632	4.6	517	2.6

Note. *Adjusted by age and region.

TABLE 7
Adjusted Prevalence of Borderline Hypercholesterolemia* in Chinese Adults (%)

Age Group (Years)	Total		Urban		Rural	
	Case	%	Case	%	Case	%
18-44	629	2.6	249	3.5	380	2.3
Male	365	3.4	141	4.4	224	3.0
Female	264	2.0	108	2.8	156	1.6
45-59	968	5.9	461	8.1	507	5.1
Male	381	5.1	170	6.8	211	4.5
Female	587	6.6	291	9.1	296	5.7
≥60	757	6.2	446	6.1	311	6.3
Male	274	5.8	158	8.4	116	4.8
Female	483	9.2	288	13.2	195	7.7
Total	2354	3.9	1156	5.1	1198	3.3
Male	1020	3.9	469	5.1	551	3.4
Female	1334	3.9	687	5.3	647	3.3

Note. *Adjusted by age and region.

Hypertriglyceridemia The adjusted prevalence of hypertriglyceridemia was 11.9%, 14.5% in males, and 9.9 % in females. In groups at the age of 18-44, 45-59, and ≥ 60 years, the prevalence was 10.9%,

15.7%, and 14.8%, respectively. Hypertriglyceridemia prevalence was higher in participants from urban districts than in those from rural areas (14.2% vs. 10.9%) (Table 8).

TABLE 8

Adjusted Prevalence of Hypertriglyceridemia* in Chinese Adults (%)

Age Group (Years)	Total		Urban		Rural	
	Case	%	Case	%	Case	%
18-44	2730	10.9	882	12.3	1848	10.3
Male	1790	16.0	662	20.4	1128	14.0
Female	940	6.6	220	5.6	720	7.0
45-59	2677	15.7	1088	20.4	1589	13.9
Male	1277	16.1	562	23.7	715	13.2
Female	1400	15.5	526	17.8	874	14.6
≥ 60	1473	14.8	787	20.5	686	12.6
Male	600	11.8	347	18.3	253	9.4
Female	873	17.7	440	22.8	433	15.8
Total	6880	11.9	2757	14.2	4123	10.9
Male	3667	14.5	1571	19.6	2096	12.4
Female	3213	9.9	1186	10.1	2027	9.8

Note. *Adjusted by age and region.

Low HDL-cholesterol The adjusted prevalence of low HDL-cholesterol was 7.4% in adults, 9.3% in males, and 5.4% in females. In groups at the age of 18 -44, 45 -59, and ≥ 60 years, the prevalence was 7.3%, 7.2%, and 7.0%, respectively.

The adjusted prevalence of low HDL-cholesterol was 7.1% in participants from urban districts and 7.5% in those from rural areas. The prevalence was significantly higher in males than in females (Table 9).

TABLE 9

Adjusted Prevalence of Low HDL-cholesterol* in Chinese Adults (%)

Age Group (Years)	Total		Urban		Rural	
	Case	%	Case	%	Case	%
18-44	1774	7.3	467	6.6	1307	7.6
Male	1073	9.7	326	10.2	747	9.4
Female	701	5.2	141	3.7	560	5.9
45-59	1181	7.2	420	7.9	761	6.9
Male	704	8.9	267	11.1	437	8.1
Female	477	5.8	153	5.3	324	5.9
≥ 60	655	7.0	268	6.7	387	7.1
Male	398	8.3	173	8.6	225	8.3
Female	257	5.7	95	4.9	162	6.0
Total	3610	7.4	1155	7.1	2455	7.5
Male	2175	9.3	766	10.0	1409	9.0
Female	1435	5.4	389	4.3	1046	5.9

Note. *Adjusted by age and region.

DISCUSSION

Blood lipid is an important indicator for health.

Dyslipidemia is the leading risk factor for coronary heart disease^[12-16]. Prior to this survey, no representative data could have been used to

determine the lipid profile and the prevalence of dyslipidemia in Chinese adults. The data obtained from this survey may provide scientific evidence for the prevention and control of cardiovascular diseases in the Chinese population. It is estimated that there are approximately 160 million Chinese adults affected with dyslipidemia. These patients with dyslipidemia should be given more attention from public health communities.

The mean plasma TC level is significantly lower in Chinese adults than in Americans^[17]. The results indicated that the mean levels of TC and TG and the prevalence of hypercholesterolemia and hypertriglyceridemia were significantly lower in the group at the age of 18-44 years than in the groups at the age of 45-59 and ≥ 60 years. It should be noted that there was no significant difference between groups at the age of 45-59 and ≥ 60 years, suggesting that the prevention and control of dyslipidemia in the middle aged Chinese are very important in the future.

Hypertriglyceridemia and low blood HDL-cholesterol are the two major types of dyslipidemia in Chinese adults. In Western countries hypercholesterolemia is the major lipid abnormality. Hypertriglyceridemia and low HDL-cholesterol are also the risk factors for diabetes and cardiovascular diseases^[18-21]. In this study, the prevalence of borderline hypercholesterolemia was 3.9% in Chinese adults, although the prevalence of hypercholesterolemia was not very high (2.9%).

The mean TC and TG level and the prevalence of dyslipidemia were significant higher in participants from urban districts than in those from rural areas. This could be due to the significant variations in diet, lifestyle and related variables between urban and rural residents^[1,2,10,12].

In conclusion, dyslipidemia has become one of the important risk factors for the increasing prevalence of cardiovascular diseases in China. There is lack of awareness on the relationship between blood lipids and the risk of cardiovascular diseases among Chinese^[1,10,20]. The strategy of early prevention should be adopted against dyslipidemia in China. We suggested that the guidelines for the treatment and prevention of dyslipidemia in Chinese should be revised.

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REFERENCES

1. Zhaosu Wu, Chonghua Yao, Dong Zhao, *et al.* (1997). Multiprovincial monitoring of trends and determinants in cardiovascular diseases (Sino-MONICA project)- II: Result of risk factor monitoring. *Chin J Cardiol* **25**, 255-259. (In Chinese)
2. Ying Li, Beifan Zhou, Yangfeng Wu, *et al.* (1996). Plasma Cardiology total cholesterol levels and distribution characteristics in China. *Chinese Journal of Prevention and Control of Chronic Non-communicable Diseases* **5**, 200-202.
3. Ministry of Health. Health Statistic Yearbook of China, 1990-2000.
4. National Bureau of Statistics of China (1995). Statistical Yearbook of China, Statistical Publishing House of China, Beijing, 1995.
5. Ge K Y, Zhai F Y, Yan H C (1996). The dietary and nutritional status of Chinese. Population (1992 National Nutrition Survey). People's Medical Publishing House, Beijing.
6. Ge K Y (1996). Changes of dietary pattern of Chinese population. *Wei Sheng Yan Jin* **25**(S29), 28-32. (In Chinese)
7. Zhao F J, Guo J, Chen H (1995). Studies on the relationship between changes in dietary patterns and health status. *Asia Pac J Clin Nutr* **4**, S24-28.
8. Chen J S, T Colin Campbell, Li J Y, *et al.* (1991). Diet, life-style and mortality in China: A study of the characteristics of 65 Chinese counties. People's Medical Publishing House, Beijing.
9. Committee on Diet and Health, National Research Council (1989). Diet and health: implication for reducing chronic disease risk. Food and Nutrition Board. Commission on Life Sciences, National Research Council, 1989.
10. Longde Wang (2005). The nutrition and health status of Chinese. The people hygiene publishing company.
11. The groups of preventing dyslipidaemia of Chinese journal of cardiology editor committee (1997). Propose of preventing dyslipidaemia. *Chin J Cardiol* **25**, 169-173.
12. He J, Gu D, Reynolds K, Kristi R, *et al.* (2004). Serum total and lipoprotein cholesterol levels and awareness, treatment, and control of hypercholesterolemia in China. *Circulation* **110**, 405-411.
13. Gardner C D, Winkleby M A, Fortmann S P (2000). Population Frequency Distribution of Non-High-Density Lipoprotein Cholesterol (Third National Health and Nutrition Examination Survey [NHANES III, 1988-1994]). *Am J Cardiol* **86**, 299-304.
14. Rodriguez C, Pablos-Mendez A, Palmas W, *et al.* (2002). Comparison of modifiable determinants of lipids and lipoprotein levels among African-Americans, Hispanics, and Non-Hispanic Caucasians ≥ 65 years of age living in New York City. *Am J Cardiol* **89**, 178-183.
15. Heim D L, Holcomb C A, Loughin T M (2000). Exercise mitigates the association of abdominal obesity with high-density lipoprotein cholesterol in premenopausal women: results from the third National Health and Nutrition Examination Survey. *J Am Diet Assoc* **100**, 1347-1353.
16. Zhang J, Man Q Q, Wang G R, *et al.* (2005). Study on the adult plasma lipids level among different areas in China. *Zhong Hua Yu Fang Yi Xue Za Zhi* **39**, 302-305. (In Chinese)
17. Zhao W H, Zhang J, You Y, *et al.* (2005). Study on the Epidemiological Characteristics of Dyslipidemia in China. *Zhong Hua Yu Fang Yi Xue Za Zhi* **39**(5), 306-310. (In Chinese)
18. NCEP (2004). NHANES III *Circulation* **110**, 227-239.
19. Hu F B, Willett W C (2002). Optimal diets for prevention of coronary heart disease. *JAMA* **288**(20), 2569-2578.

20. Dwyer J T (2001). Chronic disease and dietary management in the elderly: alive and kicking! *J Nutr Health Aging* **5**, 103-107.
21. Zhao W H, Chen J S (2001). Implications from and for food cultures for cardiovascular disease: diet, nutrition and cardiovascular disease in China. *Asia Pac J Clin Nutr* **10**(2), 146-152.

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