Letter to the Editor

Prevalence of High Non-high-density Lipoprotein Cholesterol and Associated Risk Factors in Patients with Diabetes Mellitus in Jilin Province, China: A Cross-sectional Study*

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Dyslipidemia is a risk factor for cardiovascular diseases (CVDs) in patients with diabetes, and non-high-density lipoprotein cholesterol (non-HDL-C) is a better predictor of CVDs than low-density lipoprotein cholesterol (LDL-C) in patients with diabetes. Therefore, we aimed to investigate the distribution of non-HDL-C and the prevalence of high non-HDL-C level in Chinese patients with diabetes mellitus and identify the associated risk factors. Non-HDL-C concentration positively correlated with total cholesterol, triglycerides, and LDL-C concentrations. Although both non-HDL-C and LDL-C concentration both related positively with TC concentration, the magnitude of correlation was relatively higher for non-HDL-C. The prevalence of high non-HDL-C (≥4.14 mmol/L) was higher in two age groups (55-64 years: 46.7%; 65-79 years: 47.3%) than other age groups (18-24 years: 4.2%; 25-34 years: 43.6%; 35-44 years: 38.1%; 45-54 years: 41.0%). It was also higher among overweight (45.1%), generally obese (50.9%), or abdominally obese (47.3%) subjects, compared with normal weight subjects (34.5%). The risk of high non-HDL-C increased with advancing age. Both general obesity [odds ratio (OR)=1.488, 95% confidence interval (CI): 1.003-2.209] and abdominal obesity (OR=1.561, 95% CI: 1.101-2.214) were significantly associated with high non-HDL-C levels.

Diabetes is associated with a greater risk of morbidity and mortality from cardiovascular diseases (CVDs)[1]. The coexistence of diabetes and other risk factors, in particular dyslipidemia, further increases the risk of CVDs[2], and 'lipotoxic' dyslipidemia can accelerate the manifestation and persistence of complications of diabetes[3]. The United Kingdom Prospective Diabetes Study (UKPDS) also showed that dyslipidemia was a risk factor for CVDs in patients with diabetes[4]. Previous studies demonstrated that an elevated level of low-density lipoprotein cholesterol (LDL-C) was a powerful coronary heart disease risk factor and recommended using LDL-C as the primary marker to guide therapy[5]. The Third Adult Treatment Panel (ATP III) of the National Cholesterol Education Program (NCEP) suggested that non-high-density lipoprotein cholesterol (non-HDL-C) be used as a secondary target for lipid control[5]. A recent study also reported that non-HDL-C was a better predictor of CVDs than LDL-C in patients with diabetes[6]. Estimation of non-HDL-C levels, which is calculated by subtracting HDL-C from total cholesterol (TC), does not require measurement of triglyceride (TG) or LDL-C levels, and it is not influenced by plasma TG concentration[5]. Non-HDL-C reflects the concentrations of both cholesterol-rich and TG-rich atherogenic apolipoprotein B-containing lipoproteins, including very-low-density lipoprotein cholesterol (VLDL-C), intermediate-density lipoprotein cholesterol (IDL-C), LDL, and lipoprotein (a)[5]. Most studies on non-HDL-C are performed for normal populations. Very few cross-sectional studies have been performed to investigate the prevalence of high non-HDL-C and associated factors among patients with diabetes in China. In this study, we aimed to describe non-HDL-C levels among patients with diabetes mellitus, examine the prevalence of high non-HDL-C levels and the risk factors influencing high non-HDL-C levels in patients with diabetes mellitus in Jilin Province, China.

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Data for this study were collected from the Survey of Chronic Diseases and Associated Risk Factors among Adults in Jilin Province, China in 2012. The survey was a cross-sectional study that used a multistage cluster random sampling design to select a representative sample of permanent residents aged 18 to 79 years in nine different cities in Jilin Province. The survey is described in detail elsewhere[7]. A total of 16,975 participants completed the survey. Participants with incomplete information on blood glucose or lipid levels were excluded from the present study. Our study sample consisted of 1825 patients with diabetes mellitus, which was defined as fasting plasma glucose (FPG) level ≥7.0 mmol/L, 2-h post prandial plasma glucose (2hPG) concentration ≥11.1 mmol/L, patient administering anti-diabetic medications, or having a history of diabetes mellitus in the past one year.

To account for the complex sampling design, prevalence rates were weighted to produce representative estimates of the total population of Jilin Province. The weights were obtained from the 2010 Chinese population census data and calculated based on four factors: geographical region, residential type (urban/rural), sex, and age.

Of 1825 patients with diabetes mellitus (representing 2,074,217 subjects), 54.4% resided in urban areas while 45.6% resided in rural areas. There was a 56.4% male predominance. The mean age of subjects was 53.20±0.55 years, with 29.0% of them aged 55-64 years, 28.1% aged 45-54 years, and 1.7% aged 18-24 years. Other characteristics of the study sample population are shown in Table S1 (See the BES website: www. besjournal.com).

In our study, the weighted mean levels of TC, TG, LDL-C, HDL-C, and non-HDL-C were 5.31±0.04 mmol/L, 2.98±0.09 mmol/L, 3.11±0.03 mmol/L, 2.13±0.10 mmol/L, and 4.07±0.04 mmol/L, respectively (Table 1). These values were higher than those reported for the general and normal population[8], and these levels are similar to the levels reported by Wagner et al.[9] for patients with type 2 diabetes.

A positive correlation between non-HDL-C and TG concentrations was observed (r=0.531, P<0.001) (Figure 1A), but the correlation between LDL-C and TG concentrations was not significant (r=-0.040, P=0.087) (Table S2, see the BES website: www.besjournal.com). Although both non-HDL-C (r=0.947, P<0.001) (Figure 1B, see the BES website: www.besjournal.com) and LDL-C (r=0.717, P<0.001; Table S2) concentration positively correlated with TC, the magnitude of correlation was relatively higher for the former. Non-HDL-C concentration significantly correlated with LDL-C concentration (r=0.657, P<0.001) (Figure 1C), and non-HDL-C exhibited a significant inverse relationship to HDL cholesterol (r=-0.101, P<0.001) (Figure 1D).

The present data show that non-HDL-C concentration, unlike LDL-C, better correlated with TC concentration. Because non-HDL-C reflects the concentrations of both cholesterol-rich and triglyceride-rich atherogenic apolipoprotein B-containing lipoproteins, including VLDL-C, IDL-C, LDL, and lipoprotein (a), compared with LDL-C, non-HDL-C could be a better atherogenic index for patients with diabetes and hypercholesterolemia and/or hyper triglyceridemia.

According to the NCEP-ATPIII criteria, non-HDL-C levels are routinely calculated as TC levels minus HDL-C level. The reasonable non-HDL-C concentration was 0.78 mmol/L (30 mg/dL higher than LDL-C concentration[5]. Based on the subdivided LDL-C cut-off point, we categorized non-HDL-C concentrations into four levels: <3.37 mmol/L (130 mg/dL), 3.37-4.13 mmol/L (130-159 mg/dL), 4.14-4.90 mmol/L (160-189 mg/dL), and ≥4.92 mmol/L (190 mg/dL). We defined high non-HDL-C concentrations as those >4.14 mmol/L (160 mg/dL). As shown in Table S3 (See the BES website: www. besjournal.com), the non-HDL-concentration for 28.9% of subjects was in the range of 3.37-4.13 mmol/L, for

Table 1. Blood Glucose Concentration and Serum Lipid Levels of Study Subjects in Jilin Province, China, 2012

Variables	Weighted Mean (mmol/L)	SE	95% CI
FPG[a]	8.04	0.09	7.85, 8.22
2hPG[b]	11.39	0.47	10.46, 12.31
TC	5.31	0.04	5.23, 5.38
TG	2.98	0.09	2.80, 3.16
LDL-C	3.11	0.03	3.06, 3.17
HDL-C	1.23	0.10	1.21, 1.25
Non-HDL-C	4.07	0.04	4.00, 4.15

***Note*.** FPG[a], Fasting plasma glucose (1694 study subjects, representing 1,947,369 subjects); 2hPG[b], 2-h post prandial plasma glucose (131 study subjects, representing 126,848 subjects).