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# Classified status of smoking and quitting has different associations with dyslipidemia in residents in northeast China

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ABSTRACT

*Background:* Various smoking status and high prevalence of dyslipidemia in residents exist in northeast China. However, associations of dyslipidemia with smoking status remain unclear.

*Methods:* A total of 17,114 participants selected by a multistage stratified cluster random sampling design were enrolled from a cross-sectional study conducted in northeast China. Associations of dyslipidemia with smoking/quitting status (smoking amount, smoking duration, and quitting duration) were investigated using multiple logistic regression.

*Results:* Prevalence (39.2%) of dyslipidemia existed in residents in northeast China. Smoking amount was associated with dyslipidemia (1–10 cigarettes daily: *OR* = 1.19, 95% *CI*: 1.08–1.32; 11–20 cigarettes daily: *OR* = 1.29, 95% *CI*: 1.16–1.42; and over 20 cigarettes daily: *OR* = 1.51, 95% *CI*: 1.25–1.83). Smoking duration was associated with dyslipidemia risk (6–10 years: *OR* = 1.75, 95% *CI*: 1.51–2.03; 11–15 years: *OR* = 1.85, 95% *CI*: 1.51–2.26; and ≥15 years: *OR* = 1.12, 95% *CI*: 1.02–1.23). Quitting duration (1–5 years) was associated with dyslipidemia (*OR* = 1.26, 95% *CI*: 1.07–1.48); however, we found no statistically significant associations between dyslipidemia and quitting duration (over 6 years).

*Conclusions:* Dyslipidemia risk is positively associated with smoking/quitting status. Smoking amount and smoking duration may co-determine dyslipidemia risk, and quitting duration (> 6 years) is necessary for reducing dyslipidemia risk.

## 1. Introduction

Dyslipidemia refers to abnormal levels of lipids in blood, leading to an increased incidence of cardiovascular diseases (CVD), such as hypertension, atherosclerosis, heart failure, and myocardial infarction. CVD remains the leading cause of death in urban and rural population of China [1], and the prevalence of CVD is estimated to achieve > 50% in next 20 years in China [2–4]. Notably, dyslipidemia is one of the independent risk factors for CVD [5, 6]. Thus, controlling dyslipidemia is necessary for CVD prevention.

Controlling dyslipidemia comprises medication and the long term maintenance of healthy lifestyles. The medication is the first choice for patients with dyslipidemia. For people susceptible to dyslipidemia, however, the long term maintenance of healthy lifestyles is indispensable.

Cigarette smoking, a major unhealthy lifestyle, is one of the environmental risk factors of dyslipidemia [7]. Moreover, one third of global cigarettes are consumed in China alone [8]. Our team has investigated the awareness of dyslipidemia in adults, and investigated the prevalence of passive cigarette smoking among women in northeast China [9, 10]. However, the association between dyslipidemia and active cigarette smoking, as well as the association between dyslipidemia and quitting smoking, still remain unclear in this region. Thus, in this study, we further classified active cigarette smoking into smoking amount and smoking duration, and selected quitting time as the index of quitting smoking, to investigate the relationships between the different smoking/quitting status and dyslipidemia in the residents in northeast China.

## 2. Materials and methods

### 2.1. Ethical statement

The study was approved by the Institutional Review Board of the School of Public Health, Jilin University. All participants signed informed consents.

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### 2.2. Study population

This study was based on data acquired from the Project on Present Situation and Change Forecast of Disease Spectrum in Jilin Province of China in 2012. The data were collected from residents who had lived for at least six months in Jilin province. The investigation was a cross-sectional study under a multistage stratified cluster random sampling design. We enrolled residents aged from 18 to 79 in nine different cities, 32 districts or counties, 95 towns or communities, and 45 units. The detailed stratifying process was reported previously [11]. A total of 17,729 participants with complete lipid profiles constituted the representative sample; however, there remained 17,114 participants after the participants taking lipid-lowering drugs were excluded.

### 2.3. Interview survey and health examination

The health interview survey was established by the School of Public Health, Jilin University. Direct face-to-face interview survey was performed by uniformly trained investigators. Questionnaires and data of anthropometric measurements were collected from each participant. Demographic information, including region, age, sex, level of education, health behaviors (smoking, drinking, diet, and physical activity), and history of chronic diseases (hypertension and diabetes), was gathered from the questionnaires. BMI [weight (kg)/height $^2$ ($m^2$)] were obtained. Weight was measured before breakfast. Current smokers were defined as smokers who had smoked in the last 30 days, and past smokers were defined as smokers who had completely abstained from cigarette use for at least one month [12]. Every physical measurement was checked by two medical staffs together. Blood samples were collected in the morning after fasting for at least 8 h, and the samples were transported to a central laboratory *via* a cold chain transport system.

### 2.4. Laboratory assay

Lipid indices, including total cholesterol (TC), high density lipoprotein cholesterol (HDL−C), low density lipoprotein cholesterol (LDL-C), and triglycerides (TG), were analyzed using MODULE P800 automated biochemistry analyzer (ROCHE, USA). Dyslipidemia was defined according to the Chinese guidelines on the prevention and treatment of dyslipidemia in adults (2007) [13]: TG ≥ 2.26 mmol/L (200 mg/dL) as high; TC ≥ 6.22 mmol/L (240 mg/dL) as high; LDL-C ≥ 4.14 mmol/L (160 mg/dL) as high; and HDL-C < 1.04 mmol/L (40 mg/dL) as low [11].

### 2.5. Statistical analysis

Constituent ratio was used to represent the composition of different status of main characteristics of the participants in this investigation. *Chi-square* ($\chi^2$) test was performed to identify differences in the prevalence of dyslipidemia in age, sex, region, smoking/quitting status, BMI, and drinking. Multivariate logistic regression was performed to analyze odds ratios (*OR*) for dyslipidemia in smoking amount, smoking duration, and quitting time. Adjusted *OR* was calculated by controlling the variables (age, sex, region, diet, and drinking). Statistical analyses were performed using SPSS version 19.0 (SPSS Inc., Chicago, IL, USA), and P-values ≤ .05 were considered statistically significant.

## 3. Results

### 3.1. Dyslipidemia status in the participants

In this study, the prevalence of dyslipidemia in males was significantly higher than that in females (43.9% *vs.* 35.2%, $P < .001$). The prevalence of dyslipidemia in urban areas was significantly lower than that in countries (38.4% *vs.* 40.0%, $P < .001$). The prevalence of dyslipidemia increased with the increase of age from group (18–24 years) to group (55–64 years), but decreased in group (65–79 years) ($P < .001$). There existed significantly different in the prevalence among current-smokers (45.1%), ex-smokers (46.5%), and non-smokers (35.3%) ($P < .001$). The prevalence of dyslipidemia in participants with normal weight, overweight, or obese was 25.6%, 49.9%, or 60.3%, respectively ($P < .001$). The prevalence of dyslipidemia in participants with drinking habit was significantly higher than that in participants without the habit ($P < .001$). There was the significant difference of prevalence on the basis of balanced diet, vegetarian diet, and carnivorous diet (38.3%, 39.5%, and 44.0%, respectively) ($P < .001$) (Table 1).

### 3.2. Association between smoking amount and dyslipidemia

Compared with non-smokers, smokers had significantly high dyslipidemia risk (1–10 cigarettes daily: *OR* = 1.34, 95% *CI*: 1.22–1.47; 11–20 cigarettes daily: *OR* = 1.59, 95% *CI*: 1.46–1.74; and over 20 cigarettes daily: *OR* = 1.99, 95% *CI*: 1.67–2.39). After controlling the variables (age, sex, region, diet, and drinking), smoking amount still showed significant differences in dyslipidemia risk (1–10 cigarettes daily: *OR* = 1.19, 95% *CI*: 1.08–1.32; 11–20 cigarettes daily: *OR* = 1.29, 95% *CI*: 1.16–1.42; over 20 cigarettes daily: *OR* = 1.51, 95% *CI*: 1.25–1.83) (Table 2).

### 3.3. Association between smoking duration and dyslipidemia

Smoking duration (1–5 years) was significantly associated with low dyslipidemia risk before adjusting for age, sex, region, diet, and drinking (*OR* = 0.79; 95% *CI*: 0.65–0.96), but this association became insignificant after adjusting for those variables (*OR* = 1.12; 95% *CI*: 0.91–1.38). In addition, compared with non-smoking, smoking duration was all associated with high dyslipidemia risk (6–10 years: *OR* = 1.75, 95% *CI*: 1.51–2.03; 11–15 years: *OR* = 1.85, 95% *CI*: 1.51–2.26; and 15 or more years: *OR* = 1.12, 95% *CI*: 1.02–1.23) after adjusting for those variables (Table 2).

### 3.4. Smoking-duration-classified association between dyslipidemia and smoking amount

Compared with smoking amount (1–10 cigarettes daily), that (over 20 cigarettes daily) was not associated with high dyslipidemia risk in smokers with a short smoking duration (1–5 years), (*OR* = 2.644, 95% *CI*: 0.547–12.795); however, that (over 20 cigarettes daily) was associated with high dyslipidemia risk in smokers with a long smoking duration (smoking for over 15 years) (*OR* = 1.540, 95% *CI*: 1.219–1.946) (Table 3).

### 3.5. Association between quitting duration and dyslipidemia

Compared with non-smoking, quitting duration was associated with high dyslipidemia risk (1–5 years: *OR* = 1.65, 95% *CI*: 1.42–1.92; 6–10 years: *OR* = 1.61, 95% *CI*: 1.26–2.05; and over 10 years: *OR* = 1.51, 95% *CI*: 1.21–1.89). After adjusting those variables, dyslipidemia risk decreased with the increasing of quitting duration. Notably, quitting duration (1–5 years) was more likely to be significantly associated with high dyslipidemia risk than non-smoking (*OR* = 1.26, 95% *CI*: 1.07–1.48); however, we found no statistically significant associations between dyslipidemia risk and quitting duration (6–10 years: *OR* = 1.05, *95% CI:* 0.82–1.35; over 10 years: *OR* = 0.90, *95% CI:* 0.72–1.14) (Table 2).

## 4. Discussions

Geographical region and meteorological feature affect lifestyles and chronic diseases in population [14, 15]. Long harsh winter contributes to smoking habit in residents in northeast China. Moreover, the residents exhibit various smoking status. The high prevalence of