International Journal of Cardiology 260 (2018) 196–203

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Prevalence of dyslipidemia and achievement of low-density lipoprotein cholesterol targets in Chinese adults: A nationally representative survey of 163,641 adults

Mei Zhang [a,1,2], Qian Deng [b,1,2], Linhong Wang [a,1], Zhengjing Huang [a,1], Maigeng Zhou [a,1], Yichong Li [c,1], Zhenping Zhao [a,1], Yawei Zhang [d,*,1,3], Limin Wang [a,**,1,3]

[a] National Center for Chronic and Non-Communicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing, China
[b] Healthy China Research Center, Tus-Digital Group, Beijing, China
[c] Peking University Clinical Research Institute, Beijing, China
[d] Surgical Outcomes and Epidemiology Department of Surgery, Yale School of Medicine, New Haven, CT, USA

ARTICLE INFO

Article history:
Received 2 May 2017
Received in revised form 13 December 2017
Accepted 20 December 2017

Keywords:
China
Cross-sectional study
Cholesterol
Dyslipidemia
Risk assessment

ABSTRACT

Background: Elevated serum total cholesterol and low-density lipoprotein cholesterol (LDL-C) levels are established risk factors for cardiovascular diseases, a leading cause of death in China. We sought to assess the latest levels of serum lipids, prevalence of dyslipidemia and achievement of LDL-C lowering targets among Chinese adults.
Methods: Data was obtained from a national representative survey recruited 163,641 adults aged > 18 years in mainland China between 2013 and 2014. Fasting serum total cholesterol (TC), LDL-C, high-density lipoprotein cholesterol (HDL-C), and triglycerides (TG) were measured by standard methods. Multiple logistic regression was preformed to estimate potential risk factors for dyslipidemias. Proportion of residents not achieve the therapeutic goals for LDL-C by atherosclerotic cardiovascular diseases (ASCVD) risk stratification were evaluated.
Results: Nationally, the population-weighted means of TC, HDL-C, and LDL-C, and median of TG were 4.70, 1.35, 2.88, and 1.49 mmol/L, respectively. The prevalence of high TC, high LDL-C, low HDL-C and high TG was 6.9%, 8.1%, 20.4% and 13.8%. Among individuals with high ASCVD risk, 74.5% had uncontrolled LDL-C levels (<2.6 mmol/L) and 5.5% of them were treated. For very-high-risk individuals, 93.2% didn't achieve their LDL-lowering goals (<1.8 mmol/L) and 14.5% of them were treated.
Conclusions: Chinese adults currently experienced a high prevalence of abnormal serum lipid levels, more common in urban adults or those with obesity or central obesity. A significant proportion of people with high or very high ASCVD risk didn't meet LDL-C targets. Improvements in achievement of lipid-level targets and of LDL-lowering therapy rates based on ASCVD risk stratification were necessary.

1. Introduction

Over the last two decades, China has experienced rapid transitions due to urbanization, a rising economy, and an aging population, which has also triggered a change in the spectrum of diseases. In 2010 and 2013, cardiovascular disease became the leading cause of death and the leading contributor to disability-adjusted life-years (DALYs) in both men and women in China [1–3].Increased total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels have been well known as the major risk factors for cardiovascular diseases (CVD) [4–6]. Decreased high-density lipoprotein cholesterol (HDL-C) levels also was considered to increase the risk of CVD [7]. In China, the first report based on a nationally representative sample showed an increasing trend of TC, LDL-C, and TG levels between the 1980s and 2000–2001 and that hypercholesterolemia was not controlled adequately [8]. A subsequent national survey based on a larger sample size and more age groups confirmed the increasing trend [9]. It has been estimated that full adherence to the National Cholesterol Education Program Adult Treatment Panel III (ATP III) Primary Prevention Guidelines would prevent 20,000 myocardial infarctions and 10,000 deaths from coronary heart disease (CHD) per year in adults in the United States [10]. Moreover, a

* Correspondence to: Y. Zhang, Yale University School of Public Health, 60 College Street LEPH 440, New Haven, CT 06520, USA.
** Correspondence to: L. Wang, National Center for Chronic and Non-Communicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention, 27 Nanwei Road, Xicheng District, Beijing 100050, China.
E-mail addresses: yawei.zhang@yale.edu (Y. Zhang), wanglimin@ncncd.chinacdc.cn (L. Wang).
[1] This author takes responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.
[2] Dr. Zhang and Dr. Deng contributed equally.
[3] Dr. Zhang and Prof. Wang contributed equally.

https://doi.org/10.1016/j.ijcard.2017.12.069
0167-5273/

meta-analysis has suggested that 1 mmol/L reduction of LDL-C could prevent 11 per 1000 major vascular events over 5 years [11]. Lower achieved LDL-C levels were associated with lower rates of major coronary events [12]. The latest guidelines on CVD prevention all recommend that the treatment of hypercholesterolemia for primary prevention of CVD should be in accordance with individual's overall risk level of developing atherosclerotic cardiovascular diseases (ASCVD). Although the recent ACC/AHA guideline [13] in the USA no longer recommend a target based approach to the use of lipid lowering treatment, the European guideline and Chinese guideline continue to recommend target levels of TC or LDL-C for individuals with diverse ASCVD risk [14,15]. In a group of adults from 12 European counties, 65.3% with high CVD risk were receiving lipid-lowering therapy and 61.3% of treated patients had uncontrolled LDL-C [16]. However, little is known about treatment rates and achievement of LDL-lowing treatment targets according to the ASCVD risk stratification in Chinese adults. Using data from the 2013–2014 China Chronic Disease and Risk Factor Surveillance (CCDRFS), we aimed to (i) examine the current lipid profile and prevalence of high total cholesterol (high TC), high LDL-C and low HDL-C, and hypertriglyceridemia (high TG) among Chinse adults aged ≥18 years; (ii) explore the potential risk factors for different types of dyslipidemia; (iii) assess the achievement of LDL-lowering therapy targets among Chinese adults and treatment status among those didn't achieve the goals, both overall and in diverse ASCVD risk level.

2. Methods

2.1. Data source and study population

The CCDRFS, an ongoing, nationwide representative cross-sectional survey, has been conducted once every three years since 2004 by National Center for Chronic and Noncommunicable Disease Control and Prevention (NCNCD), Chinese Center of Disease Prevention and Control (China CDC) [17,18]. The CCDRFS has been designed to assess the prevalence and changes over time of major non-communicable and chronic diseases (NCDs) and their risk factors in the Chinese civilian noninstitutionalized population using the national Disease Surveillance Points System (DSPs) [19,20].

The fourth CCDRFS was carried out in 2013–2014 based on 298 surveillance points (177 counties in rural areas and 121 districts in urban areas) covering the geographic areas of all 22 provinces, 5 autonomous regions, and 4 municipalities in mainland China (Supplementary Fig. 1). The details of sampling schemes have been reported previously [21]. Of 178,800 individuals selected, 177,099 participated in the survey. About 6.3% of the sampled families could not be accessed on three attempts in different 3 days, who were replaced by another household with a similar family structure in the same village or residential area.

2.2. Date collection

The 2013–2014 CCDRFS collected data through centralized interviews and physical measurements in examination centers at local community clinics or health stations. A standardized and structured questionnaire was administered by trained study interviewers through in-person interviews. The collected data included demographic information, tobacco use, alcohol consumption, dietary habit, physical activity, self-reported chronic diseases, and medication use. Physical measures (e.g. height, weight, waist circumference, and blood pressure) were performed according to a standard protocol. Blood samples were collected from all participants after an overnight fast of at least 10 h. Plasma samples were tested for blood glucose in local laboratories successfully completed a standardization and certificating program. Serum samples for lipids tests were frozen at −80 °C within 2 h of collection and shipped by air in dry ice to a central laboratory in Guangzhou, which was certificated by the College of American Pathologists. Serum TC, LDL-C, HDL-C, and TG were tested by using an ROCHE COBAS C702 Automated clinical chemistry analyzer (ROCHE DIAGNOSITICS, IN, USA) with stringent quality control procedure. TC concentration was measured by cholesterol oxidase method, LDL-C and HDL-C concentrations by direct method, and TG concentration by enzymatic method. The ethics committee of NCNCD proved the survey. Each participant was informed and signed a written consent. The survey protocol abided the ethical guidelines of the 1975 declaration of Helsinki.

The 2016 Chinese Guideline for the Management of Dyslipidemia in Adults (Chinese guideline) [15] was used to classify the serum TC, LDL-C, HDL-C, and TG levels. These classifications defined by Chinese guideline were the same with the criteria in the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report (NCEP-ATP III) [22]. High TC was defined as TC ≥ 6.22 mmol/L. High LDL-C was defined as LDL-C ≥ 4.14 mmol/L. Low HDL-C was defined as LDL-C < 1.04 mmol/L and high TG was defined as TG ≥ 2.26 mmol/L. To identify the CVD risk stratification and defined the therapeutic targets, we also used the recommendations of the Chinese guideline [15,23]. Patients already had stroke or myocardial infarction were considered as with very high ASCVD risk. Individuals with LDL-C ≥ 4.9 mmol/L, or TC ≥ 7.2 mmol/L, or with diabetes and age ≥40 years and 1.8 mmol/L ≤ LDL-C < 4.9 mmol/L or 3.1 ≤ TC < 7.2 mmol/L were classified into high risk group. Overall risks for ASCVD in individuals except above were assessed using risk evaluation plan recommended by Chinese guideline, which estimating 10-year risk for first occurrence of ASCVD based on their age, gender, hypertension history, smoking status, HDL—C, TC and LDL-C levels. Individuals were stratified into three risk groups: high (10-year risk for ASCVD ≥ 10%), moderate (10-year risk for ASCVD 5%–9%) and low (10-year risk for ASCVD < 5%). The LDL-C treatment goals are as follows: <1.8 mmol/L for very high-risk patients, <2.6 mmol/L for high risk individuals, and <3.4 mmol/L for low or moderate risk individuals. Individuals didn't meet related LDL-lowering goals according to the ASCVD risk were considered as not achieving the targets for LDL-C [15]. Treatment of LDL-C was defined as self-report of taking cholesterol-lowering medication(s).

Household income per capital was classified by quartile: Q1 (<$1093); Q2 ($1093 to $1967); Q3($1968 to $3825); Q4(>$3825). Based on the status of smoking self-reported at the time of survey and referred to the definition of Global Adults Tobacco Survey [24], individuals were categorized into three groups: never, former, and current smokers. Respondents were asked whether they had ever drunk any kind of alcoholic beverage over the past 12 months; if yes, they were asked to provide information on frequency, types and quantity consumed in a typical day. Pure alcohol was calculated. Low-to-moderate drinkers were defined as those drank equal to or <25 g pure alcohol per drinking day for men and equal to or <15 g for women, while excessive drinkers were defined as those drank >25 g pure alcohol per drinking day for men and >15 g for women [25]. Body mass index (BMI, kg/m^2) was calculated from the height and weight measurements. Based on the Criteria of Weight for Adults released by the Ministry of Health of China (WS/T 428–2013), individuals were categorized into four groups: BMI < 18.5 kg/m^2 (low weight), 18.5 kg/m^2 ≤ BMI < 24.0 kg/m^2 (normal weight), 24.0 kg/m^2 ≤ BMI < 28.0 kg/m^2 (over weight), and BMI ≥ 28.0 kg/m^2 (obesity). Men with waist circumference ≥ 90 cm or women with waist circumference ≥ 85 cm was defined as central obesity. We didn't use the weight criteria recommend by the World Health Organization, because previous study have proved that Chinese criteria has the best sensitivity and specificity for identification of NCDs related risk factors among Chinese adults [26]. Individuals ate red meat ≥100 g/d were considered as over intaking red meat [27]. Physical activity was measured by using the Global Physical Activity Questionnaire [28]. The individuals did moderate or vigorous physical activity <150 min per week were considered as physical inactivity [29].

2.3. Statistical analysis

Of 177,099 participants completed the interview, the following individuals were excluded: 565 from one surveillance site due to the poor data quality, 1351 whose lipid profiles were not assessed, 8328 with missing data of category variables or risk factors for ASCVD risk calculation, and 3214 from 5 surveillance sites that failed to pass the laboratory quality control. Finally, a total of 163,641 (92.4% of enrolled) subjects were included in the analyses.

All results including means, medians, proportions and prevalence were weighted to represent the overall Chinese adult population. Weight coefficients consisted of two components: sampling weights accounting for unequal probabilities of sample selection, and post-stratification weights which harmonized the sample structure of survey with that of 2010 Chinese population census. While doing the post-stratification weights calculation, we considered the age (5-year increments), gender, rural/urban residence, and provinces. Mean levels and standard deviation (SD) of TC, HDL-C, LDL-C, and median and interquartile range (IQR) of TG were estimated overall and by subgroups including demographic characteristics (gender and age group), socioeconomic status (educational level, annual household income per capita), place of residence (rural/urban) and chronic risk factors (body mass index, central obesity, smoking, drinking, red meat intake and physical activity). A *t*-test was used to compare lipid levels between nominal categories (e.g., gender, region, central obesity, red meat intake) and a linear regression was used to test the lipid trend along order variables (e.g., age, education level, household income, BMI). Prevalence and 95% confidence intervals (CIs) of high TC, high LDL-C, low HDL-C, and high TG were calculated for the overall population and by demographic variables and risk factors. Chi-squared tests were used to compare the differences of prevalence among nominal categories and logistic regressions were used to test their trends along ordered variables. Multivariate logistic regression analyses were performed to explore potential risk factors of different type of dyslipidemia. Chi-squared tests were also used to compare the differences of proportion of lipids fraction levels between men and women as well as urban areas and rural areas. For 95% CIs and statistical tests, we estimated sampling error using Taylor series linearization with finite population correction. A *P* value <0.05 was considered statistically significant and all tests were two-sided. All statistical analyses were performed in SAS, version 9.4 (SAS Institute, Inc., Cary, North Carolina).

3. Results

Of the 163,641 participants, 42.6% were men. The mean age was 51.6 (SD:14.7) years for men and 51.4(13.8) years for women (data not shown in tables and figures). Compared to women, more men were current smoking, drinking excessively, over intaking red meat, and physical inactivity (Table 1).