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Type 2 diabetes mellitus incidence in Chinese: Contributions of overweight and obesity

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ABSTRACT

Aims: To estimate the incidence of Type 2 diabetes mellitus (T2DM) and the number of those with T2DM attributable to overweight and obesity in China.
Methods: We conducted a prospective cohort study among 15 680 participants (46.4%, men) aged 35–74 years. The mean duration of follow-up was 8.0 years. We examined the relationship between overweight, obesity and risk of T2DM by Cox proportional hazards models. Population attributable risk (PAR) of overweight and obesity was also calculated. Moreover, we estimated the number of T2DM events attributed to overweight and obesity using PAR, incidence of T2DM and the population size of China in 2010.
Results: During a mean follow-up of 8.0 years, the age-standardized incidence of T2DM was 9.5 per 1000 person-years in men and 9.2 in women. Overweight accounted for 28.3% (95% confidence interval [CI]: 20.1, 36.2) of incident T2DM among men and 31.3% (95% CI: 25.5, 36.9) among women. The corresponding PAR of obesity was 10.1% (95% CI: 6.0, 14.2) among men and 16.8% (95% CI: 12.0, 21.6) among women. Approximately 3.32 million (95% CI: 2.47, 4.24) incident T2DM were attributable to overweight and obesity in Chinese adults who were 35 to 74 years in 2010.
Conclusion: Our results indicate that incident T2DM is mainly attributable to overweight and obesity in China. It is extremely important to advocate healthy lifestyle and prevent excessive weight gain for reducing T2DM burden in China.

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1. Introduction

Type 2 diabetes mellitus (T2DM) is a global health problem that threatens almost all nations in the world. The International Diabetes Federation estimated the total number of people with diabetes was 381.8 million in 2013 and is expected to rise to 591.9 million by 2035 [1]. China is the world's most populous country and the largest developing country, which has enjoyed impressive economic developments over the past two decades. However, the prevalence of diabetes has been increasing sharply with rapid economic development, nutrition transition, changing lifestyle and so on [2–5]. In 1994, the prevalence of diabetes was 2.5%, almost threefold increase compared with 1980 (0.9%) [6]. Yang and colleagues reported that the prevalence of total diabetes was 9.7% in the Chinese population in 2007 [7]. The most recent national survey in 2010 reported that the rate of diabetes was elevated to 11.6%, representing an estimated 113.9 million adults with diabetes in China [8]. These numbers indicate that China has overtaken India as the global epicenter of the diabetes epidemic. T2DM is a huge challenge to our nation's health and economy [2]. Notably, one important factor that contributes to the rapid growth of diabetes in China and other developing countries is the increasing prevalence of overweight and obesity [3,9]. The prevalence of overweight and obesity increased significantly among Chinese nearly over the last two decades [10–14]. In 2010, the prevalence of overweight and obesity (body mass index, BMI cut off points: 25.0–29.9 kg/m^2 for overweight, $\geq$30 kg/m^2 for obesity) in Chinese adults aged over 18 years old was 27.9% and 5.1%, respectively [14].

Nowadays, several prospective studies have examined the relationship between overweight/obesity and incidence of T2DM [15,16]. However, few cohort studies have been conducted, and the incidence of overweight and obesity-attributable T2DM has not been rigorously estimated in the general population in China or other developing countries. In the present report, we aim to investigate the association between overweight, obesity and incidence of T2DM among Chinese adults, and estimate the population attributable risks (PARs) and incidence of T2DM attributable to overweight and obesity in China in 2010, using data from a prospective cohort study of Chinese adults. These estimates could aid the prevention and control of T2DM in China.

2. Methods

2.1. Study population

All study participants came from two prospective cohort studies: China Multicenter Collaborative Study of Cardiovascular Epidemiology (ChinaMUCA) and China Cardiovascular Health Study. ChinaMUCA started in 1998, included 15 clusters which were selected on the basis of the main characteristics of the population in terms of geographical locations, socioeconomic status and dietary patterns. Approximately 1000 subjects with 50% women were sampled in each cluster. Of the 15 clusters, 11 accepted the invitation to participate in the follow-up study. China Cardiovascular Health Study was a cross-sectional study of cardiovascular disease (CVD) risk factors during 2000–2001. The study used a 4-stage stratified sampling method to select a nationally representative sample of the general population in China. Details of the study design and methods of ChinaMUCA [17,18] and China Cardiovascular Health Study [19] have been described elsewhere. At baseline, a total of 27 020 participants were included in the two studies.

2.2. Baseline examinations

During baseline examinations, a standard questionnaire assessing demographic characteristics, education level, lifestyle such as smoking, drinking and work-related physical activity, medical history and other risk factors was administered by trained research staff. High-school graduation was defined as having had 12 or more years of schooling. Cigarette smoking was defined as having smoked at least 400 cigarettes or 500 g tobacco leaves in a lifetime or 1 cigarette per day for 1 year or more [20]. Alcohol consumption was defined as drinking alcohol at least once a week during the last year. Work-related physical activity was assessed on the basis of subjects' occupation [21]. Participants completed a comprehensive health examination which included evaluation of anthropometric indexes, blood pressure and collection of biological specimens for assessment after the interview. All study investigators and staff members were trained and certified. Body weight and height were measured to the nearest 0.5 kg and 0.5 cm, respectively, with the participant wearing lightweight clothing and no shoes. Blood pressure was measured three times for all participants in sitting position after resting for 5 min according to a standard protocol. BMI was calculated as weight (kg)/height squared (m^2). Hypertension was defined as an average systolic blood pressure (SBP) $\geq$140 mmHg and/or an average diastolic blood pressure (DBP) $\geq$90 mmHg and/or use of antihypertensive medication within the past 2 weeks.

Overnight fasting blood samples were collected for blood glucose, total cholesterol (TC), triglyceride (TG) and high density lipoprotein-cholesterol (HDL-C). Diabetes was defined as a fasting glucose concentration $\geq$7.0 mmol/L or the use of insulin or oral hypoglycemic agents, and/or a self-reported history of T2DM. Impaired fasting glucose (IFG) was defined as a fasting glucose concentration $\geq$6.1 mmol/L and $<$7.0 mmol/L without diabetes [22]. Dyslipidemia was defined as TC $\geq$6.22 mmol/L, TG $\geq$ 2.26 mmol/L or HDL-C $<$ l.04 mmol/L in terms of criteria recommended by U.S. Adult Treatment Panel III [23,24].

2.3. Follow-up data collection

The follow-up examination was conducted in 2007 and 2008. Lifestyles and other risk factors were assessed with a standard questionnaire. Fasting glucose and lipids levels and presence of T2DM and IFG were determined as per baseline. A total of 21 556 individuals were followed up, with an overall response rate of 79.8%. Of these, participants who had a history of myocardial infarction/stroke (n = 325) or who had diabetes (n = 1180) at baseline were excluded. Participants with incomplete or invalid data on baseline diabetes status (n = 512) or BMI (n = 41) were also excluded.