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Prevalence and determinants of diabetes and prediabetes among Vietnamese adults

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ABSTRACT

Aims: We estimated the prevalence of diabetes and prediabetes among Vietnamese adults, and quantitatively evaluated association with known risk factors.
Methods: Subjects were 5602 men and 10,680 women in North Vietnam aged 30–69 years participating in community diabetes screening programs during 2011–2013. We calculated standardized prevalence rates and demographic projections for 2035, and used multinomial regression analysis to examine the associations of multiple risk factors with diabetes and prediabetes.
Results: The age-, sex- and area of residence-standardized prevalence of diabetes was 6.0% and of prediabetes was 13.5%, with higher prevalence among men than women. Population aging is projected to raise the prevalence of diabetes to 7.0% and of prediabetes to 15.7% by 2035. Older age, obesity, large waist-to-hip ratio and hypertension were each associated with higher prevalence of diabetes, whereas the opposite direction of association was observed for underweight and minority ethnicity. In addition, diabetes was positively associated with family history of diabetes in women, but inversely related to physically heavy work among men.
Conclusions: One in 17 and one in 7 adults had diabetes and prediabetes, respectively, in Vietnam. Urbanization, population aging, increased adiposity, hypertension and sedentary work are associated with the increasing prevalence of diabetes.

1. Introduction

The burden of non-communicable diseases (NCDs) has grown significantly over the past two decades, not only in high-income countries but also in low-income nations [1]. Of note, diabetes mellitus has drawn public attention for its increasing prevalence and approximately 20% increase in age-adjusted death rates between 1990 and 2010. The global estimate of diabetes prevalence among adults was 382 million in 2013 (8.3%), and is predicted to reach 592 million (8.8%) by 2035 [2].

Design of appropriate prevention and control measures requires understanding of the determinants leading to increased diabetes prevalence in disparate parts of the world. For example, although diabetes commonly occurs among populations with large body size [3], some studies suggest that leaner individuals including Asians are also prone to this disease due to chronic "fuel surfeit" and excess calories partitioned to visceral adiposity [4]. In light of Asia's rapid

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economic development, urbanization, and population aging, it is not surprising that numerous epidemiological studies document a progressively increasing rate of diabetes in Asia over the past three decades, with risk factors including advancing age, abnormal anthropometric indices, low physical activity (PA), smoking, alcohol drinking and poor diet intake [5–9].

Despite interest in how diabetes fits into the evolving burden of disease in Southeast Asia [9], including Vietnam, evidence remains limited. Epidemiological investigations in Vietnam are limited by small sample size [10], restriction to hospital data [7] or urban populations [11], or lack of age- and/or sex-standardization of diabetes prevalence rates [10,12]. In addition, the prevalence of diabetes in rural populations has been increasing rapidly worldwide [13]; however, few studies have addressed this issue in Vietnam [14], despite the fact that roughly two thirds of the population live in rural areas [15]. These limitations may make it difficult to estimate the overall burden of diabetes accurately. As a result, further epidemiological studies on diabetes in Vietnam are needed to contribute to updated global estimates of this disease.

Here, we report findings of a large cross-sectional study using data from community diabetes screening programs among adults in northeastern Vietnam. We aimed to estimate the prevalence of diabetes and prediabetes, taking into account standardization for age, sex and urban or rural residence. We also examined the association of major demographic, anthropometric, clinical and lifestyle factors with these dysglycemic states to inform prevention and control efforts, especially in rural and mountainous areas of Vietnam.

2. Methods

2.1. Study setting and procedures

This cross-sectional study uses data obtained from diabetes screening programs in communities of Thai Nguyen province, Vietnam during 2011–2013 as described previously [16]. Thai Nguyen province is the gateway to Vietnam's mountainous northeastern region, with a population of slightly over one million, of which two-thirds live in rural areas and people aged 30–69 years account for 42.4%. There are 8 major ethnic groups, with about 73% being Kinh and the remainder designated ethnic minorities [15].

Community-based screening programs for diabetes were implemented according to guidelines from the national diabetes prevention program. Individuals aged 30–69 years from the target communities were sent a form to self-evaluate their diabetes risk factors. Those who had no previously diagnosed diabetes, but had potential risk factors for diabetes as confirmed by investigators, were invited to enroll in the screening program. Screening procedures – including interviews, anthropometric and clinical measurements and blood glucose testing – were undertaken by public health specialists and laboratory technicians at community health stations.

2.2. Study subjects

During 2011 through 2013, a total of 16,730 participants aged 24–87 years took part in the screening. We sequentially excluded subjects with fasting status ≤8 h ($n = 106$) and participants aged <30 or >69 years ($n = 194$). We also excluded extreme values using Tukey's fences [17] for fasting plasma glucose (FPG) and 2-h postload plasma glucose levels (OGTT; $n = 97$), anthropometric indices and blood pressure ($n = 35$). After additional exclusion of subjects who had missing data on FPG, gender, body mass index (BMI), ethnicity, job PA, family history of diabetes and history of dyslipidemia ($n = 16$), a total of 16,282 subjects (5602 men and 10,680 women) remained for the present analysis. Ethical review for this secondary data analysis was waived by Stanford University's Institutional Review Board.

2.3. Blood glucose testing and definition of diabetes and prediabetes

Glucose levels in whole blood taken from middle or ring fingers of all enrolled participants were determined using a SureStep Glucometer (Lifescan, Milpitas, CA). Plasma glucose levels were calculated as glucose levels in whole blood multiplied by 1.11 [18]. Dysglycemic states were defined according to the 2006 World Health Organization criteria [19]: diabetes was diagnosed when FPG was ≥7.0 mmol/L (126 mg/dL) or 2-h post OGTT ≥11.1 mmol/L (200 mg/dL); impaired glucose tolerance (IGT) was diagnosed when FPG <7.0 mmol/L (126 mg/d L) and 2-h post OGTT ≥7.8 mmol/L and <11.1 mmol/L; impaired fasting glucose (IFG) was defined as FPG of 6.1–6.9 mmol/L (110–125 mg/dL) and 2-h post OGTT <7.8 mmol/L (140 mg/dL). Prediabetes refers to individuals diagnosed with either IFG or IGT [20].

2.4. Assessment of demographic, anthropometric, clinical and lifestyle risk factors

Participants were interviewed to elicit information about age, living residence, ethnic group, education level, job PA (sedentary, light, moderate or vigorous), history of disease (yes or no) including family diabetes, hypertension, cardiovascular disease and dyslipidemia. Height (cm) was measured to the nearest 0.1 cm. Weight (kg) was measured in light clothes, without shoes, to the nearest 0.1 kg. Waist circumference (cm) was measured immediately above the iliac crest, and the measurement was taken at the end of expiration. The hip circumference (cm) was measured at the maximum width over the greater trochanters. Waist-to-hip ratio (WHR) was then calculated. Systolic and diastolic blood pressure (BP) were measured using automatic sphygmomanometers (OMRON, model SEM-2, Healthcare Inc., Bannockburn, IL, USA); BP was measured twice, 1 min apart, with participants in a sitting position after resting for 5 min. The average of the two measurements is used for analyses. BMI (kg/m^2) was classified into four groups: <18.5 (underweight), 18.5–22.9 (normal), 23.0–24.9 (overweight) and ≥25.0 (obese) [21]. Abdominal obesity was defined as WC of ≥90 cm (men) or ≥80 cm (women), and high WHR was defined as WHR of ≥0.9 (men) or ≥0.8 (women) [22]. Hypertension was defined as systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg or current use of antihypertensive medication [23].

2.5. Statistical analysis

All analyses were done for men and women separately. Subject characteristics according to gender were compared

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