Original Investigation

Prevalence and Control of Diabetes in Chinese Adults

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IMPORTANCE Noncommunicable chronic diseases have become the leading causes of mortality and disease burden worldwide.

OBJECTIVE To investigate the prevalence of diabetes and glycemic control in the Chinese adult population.

DESIGN, SETTING, AND PARTICIPANTS Using a complex, multistage, probability sampling design, we conducted a cross-sectional survey in a nationally representative sample of 98 658 Chinese adults in 2010.

MAIN OUTCOMES AND MEASURES Plasma glucose and hemoglobin A_{1c} levels were measured after at least a 10-hour overnight fast among all study participants, and a 2-hour oral glucose tolerance test was conducted among participants without a self-reported history of diagnosed diabetes. Diabetes and prediabetes were defined according to the 2010 American Diabetes Association criteria; whereas, a hemoglobin A_{1c} level of <7.0% was considered adequate glycemic control.

RESULTS The overall prevalence of diabetes was estimated to be 11.6% (95% CI, 11.3%-11.8%) in the Chinese adult population. The prevalence among men was 12.1% (95% CI, 11.7%-12.5%) and among women was 11.0% (95% CI, 10.7%-11.4%). The prevalence of previously diagnosed diabetes was estimated to be 3.5% (95% CI, 3.4%-3.6%) in the Chinese population: 3.6% (95% CI, 3.4%-3.8%) in men and 3.4% (95% CI, 3.2%-3.5%) in women. The prevalence of undiagnosed diabetes was 8.1% (95% CI, 7.9%-8.3%) in the Chinese population: 8.5% (95% CI, 8.2%-8.8%) in men and 7.7% (95% CI, 7.4%-8.0%) in women. In addition, the prevalence of prediabetes was estimated to be 50.1% (95% CI, 49.7%-50.6%) in Chinese adults: 52.1% (95% CI, 51.5%-52.7%) in men and 48.1% (95% CI, 47.6%-48.7%) in women. The prevalence of diabetes was higher in older age groups, in urban residents, and in persons living in economically developed regions. Among patients with diabetes, only 25.8% (95% CI, 24.9%-26.8%) received treatment for diabetes, and only 39.7% (95% CI, 37.6%-41.8%) of those treated had adequate glycemic control.

CONCLUSIONS AND RELEVANCE The estimated prevalence of diabetes among a representative sample of Chinese adults was 11.6% and the prevalence of prediabetes was 50.1%. Projections based on sample weighting suggest this may represent up to 113.9 million Chinese adults with diabetes and 493.4 million with prediabetes. These findings indicate the importance of diabetes as a public health problem in China.

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Noncommunicable chronic diseases have become the leading causes of mortality and disease burden worldwide. It was estimated that 34.5 million deaths globally were due to noncommunicable diseases in 2010, which reflected a significant increase from 1990.[1,2] Mortality from diabetes doubled during this period and increased to 1.3 million deaths worldwide in 2010.[1] In addition, diabetes is a major risk factor for ischemic heart disease and stroke, which collectively killed an estimated 12.9 million people globally in 2010.[1,2] As the most populous country, the rapid increase in morbidity and mortality from noncommunicable diseases in China contributed to this pandemic.[3,4] According to national data, noncommunicable diseases accounted for an estimated 80% of deaths and 70% of total disease burden in China in 2005.[4]

The prevalence of diabetes has increased significantly in recent decades and is now reaching epidemic proportions in China.[5-8] The prevalence of diabetes was less than 1% in the Chinese population in 1980.[6] In subsequent national surveys conducted in 1994 and 2000-2001, the prevalence of diabetes was 2.5% and 5.5%, respectively.[7,8] The most recent national survey in 2007 reported that the prevalence of diabetes was 9.7%, representing an estimated 92.4 million adults in China with diabetes.[5] Although different sampling methods, screening procedures, and diagnostic criteria were used, these data document a rapid increase in diabetes in the Chinese population.

Recently, the American Diabetes Association (ADA) integrated glycated hemoglobin A_{1c} (HbA_{1c}) into the diagnostic criteria for diabetes in its updated 2010 guidelines.[9] Just as there is less than 100% concordance between fasting plasma glucose and 2-hour plasma glucose tests, there is not full concordance between HbA_{1c} and either glucose-based test. Therefore, the prevalence of diabetes could be underestimated in the previous national surveys based on the ADA 2010 criteria. Furthermore, the previous national surveys could not assess diabetes control in the Chinese population because HbA_{1c} was not measured. To estimate the prevalence and control of diabetes in the general Chinese population, we measured HbA_{1c}, fasting plasma glucose, and 2-hour plasma glucose in a large and nationally representative sample of 98 658 adults who were 18 years or older in 2010.

Methods

China Noncommunicable Disease Surveillance 2010 included all 162 study sites from the Chinese Center for Disease Control and Prevention's (CDC's) National Disease Surveillance Point System, which was designed to select a nationally representative sample of the general population, covering major geographic areas of all 31 provinces, autonomous regions, and municipalities in mainland China.[10] The first level of sampling was stratified by 7 geographic regions (Northeast, North, East, South, Southwest, Northwest and Central areas) and 3 municipalities (Beijing, Tianjin, and Shanghai). The second level of sampling was stratified by urban and rural locations. The third level of sampling was stratified by 4 socioeconomic strata in rural areas and 3 population size strata in urban areas. The Surveillance Point System includes approximately 1% of the total Chinese population.[10]

At each site, a complex, multistage, probability sampling design was used to select participants who were representative of civilian, noninstitutionalized Chinese adults. Only persons who had been living in their current residence for at least 6 months were eligible to participate. In the first stage, 4 subdistricts in urban areas or townships in rural areas were selected from each site with probability proportional to size. In the second stage, 3 neighborhood communities or administrative villages were selected with probability proportional to size. In the third stage, households within each neighborhood community or administrative village were listed, and 50 households were randomly selected. In the final stage, 1 person who was at least 18 years old was selected randomly from each household using a Kish selection table.[11] When the selected individual refused or was unavailable, a replacement household was selected from all households of similar composition in the same neighborhood or village after excluding the already selected households using the simple random sampling method. The replacements were used to ensure an adequate sample size within each selected neighborhood community or administrative village and to maximize the national representativeness of the surveyed samples with regard to geographic distribution, economic development, and urbanization. The households in our study were categorized into single-person households, families of couples who were married or cohabiting adults with or without children, single-parent families, or households with 3 or more cohabiting generations. The household composition information was obtained from the government household registration system, which includes personal identifiers such as name, parents, spouse, and date of birth for each member within a household who is a local permanent resident. If the second household did not participate, a third household was selected. All replacements were successfully recruited by the third sampling. If no available replacement was found in the same neighborhood or village, the nearest neighborhood or village was used. A total of 109 023 people were selected and 98 658 participated in the survey. The overall response rate was 90.5% (replacement rate, 9.25%, eTable 1 in the Supplement).

The study protocol was approved by the ethical review committee of the China CDC and other participating institutes. Written informed consent was obtained from all study participants.

Data collection was conducted in examination centers at local health stations or community clinics in the participants' residential area by trained staff according to a standard protocol. A questionnaire including information on demographic characteristics, medical history, and lifestyle factors was administered by trained interviewers. Current smoking was defined as having smoked 100 cigarettes in one's lifetime and currently smoking cigarettes. Current drinking was defined as alcohol intake more than once per month during the past 12 months. The Global Physical Activity Questionnaire was used to assess physical activity.[12] Body weight and height were measured according to a standard protocol and body mass in-

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dex (BMI), which is calculated as weight in kilograms divided by height in meters squared. Waist circumference was measured on standing participants midway between the lower edge of the costal arch and the upper edge of the iliac crest. Overweight was defined as a BMI of 25.0 to 29.9, and obesity was defined as a BMI of 30.0 or higher.[13] Central obesity was defined as waist circumference 90 cm or more in men and 80 cm or more in women.[14] Blood pressure was measured at the nondominant arm 3 times consecutively with a 1-minute interval between the measurements with the participant in a seated position after 5 minutes of rest using an automated device (OMRON Model HEM-7071, Omron Co).

Blood samples were collected in all participants after an overnight fast of at least 10 hours. Participants without a self-reported history of diabetes were given a standard 75-g glucose solution, and plasma glucose was measured at 0 and 2 hours after administration during the oral glucose tolerance test. Blood specimens for the glucose test were collected using vacuum blood-collection tubes containing anticoagulant sodium fluoride and were centrifuged on site within 2 hours of collection. Plasma glucose was measured locally using glucose oxidase or hexokinase methods within 24 hours. All study laboratories successfully completed a standardization and certification program.

The Hemoglobin Capillary Collection System (Bio-Rad Laboratories) was used to collect capillary blood samples strictly according to the manufacturer's instructions. Blood specimens prepared using this procedure were stable for up to 4 weeks at 2°C to 8°C. The capillary blood specimens were shipped and stored at 2°C to 8°C until HbA_{1c} was measured within 4 weeks after collection by high-performance liquid chromatography using the VARIANT II Hemoglobin Testing System (Bio-Rad Laboratories) at the central laboratory in the Shanghai Institute of Endocrine and Metabolic Diseases, which was certificated by the National Glycohemoglobin Standardization Program. Capillary HbA_{1c} was converted to venous values using a validated formula. In addition, we performed an internal validation study with paired samples from 6648 adults that showed high agreement in HbA_{1c} values from capillary whole blood samples prepared with the Hemoglobin Capillary Collection System vs the venous whole blood samples collected using EDTA tubes (capillary HbA_{1c} = 0.0143 + 0.9983 × [venous HbA_{1c}]).

Serum samples were aliquoted and frozen at −80°C within 2 hours of collection and shipped by air in dry ice to the central laboratory, which was certificated by the College of American Pathologists. Serum total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, and triglycerides were measured using an autoanalyser (Abbott Laboratories).

A stringent quality assurance and quality control program was implemented to ensure the validity and reliability of study data. All investigators and research staff underwent a weeklong training session on the use of standardized protocols and instruments for data collection. Only certified staff were allowed to collect data. All laboratory equipment was calibrated and blinded duplicate samples were used. All data were double entered in a database and then compared and corrected for errors.

According to the ADA 2010 criteria, *diabetes* was defined as (1) a self-reported previous diagnosis by health care professionals, (2) fasting plasma glucose level of 126 mg/dL or higher (to convert to millimoles per liter, multiply by 0.0555), (3) 2-hour plasma glucose level of 200 mg/dL or higher, or (4) HbA_{1c} concentration of 6.5% or more. *Prediabetes* or categories of increased risk of diabetes were defined as (1) fasting plasma glucose levels between 100 mg/dL and 125 mg/dL, (2) 2-hour plasma glucose levels between 140 mg/dL and 199 mg/dL, or (3) HbA_{1c} concentrations between 5.7% and 6.4% in participants without a prior diabetes diagnosis. *Awareness* was defined as the proportion of individuals who reported a history of physician-diagnosed diabetes among all patients with diabetes. *Treatment* was defined as the proportion of individuals taking diabetes medications among all patients with diabetes. *Control* was defined as the proportion of individuals with an HbA_{1c} concentration of less than 7.0% among patients with diabetes who were treated.

Demographic and metabolic characteristics of study participants were described in means (95% CIs) for continuous variables and percentages (95% CIs) for categorical variables in the overall population and in subgroups of sex, location (urban/rural), age, stages of economic development, and categories of BMI and waist circumference. Prevalence and 95% CIs of diabetes, prediabetes, and subtypes by various criteria were estimated by subgroups and overall. Each of the 162 study sites was categorized into underdeveloped, intermediately developed, or developed according to their region's gross domestic product per capita in 2009. Age-standardized prevalences of Chinese adults with diabetes and prediabetes were also estimated in the overall population and among subgroups based on China 2010 census data.

All calculations were weighted to represent the overall Chinese adult population aged 18 years or older. Weight coefficients were derived from 2010 China population census data and the sampling scheme of the current survey to obtain national estimates. Standard errors were calculated using the Taylor-linearization method appropriate for the complex survey design. A multivariable multinomial logit analysis was used to examine the association of demographic, lifestyle, and metabolic factors with the odds of diabetes and prediabetes. All *P* values are 2-tailed and have not been adjusted for multiple testing. A *P* value <.05 was considered statistically significant. All statistical analyses were conducted using the SAS system, version 9.3 (SAS Institute Inc) and SUDAAN software, version 10.0 (Research Triangle Institute).

Results

The general characteristics and metabolic risk factors of the study population are presented in **Table 1** and **Table 2**.

The prevalence of diabetes was estimated to be 11.6% (95% CI, 11.3%-11.8%) in Chinese adults, 12.1% (95% CI, 11.7%-12.5%) in men, and 11.0% (95% CI, 10.7%-11.4%) in women (**Table 3**), with an estimated prevalence of 8.1% (95% CI, 7.9%-8.3%) for newly detected diabetes: 8.5% (95% CI, 8.2%-8.8%) in men and 7.7% (95% CI, 7.4%-8.0%) in women and was 3.5%

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Table 1. General Characteristics of Chinese Adult Population

	No. of Study Participants	% (95% CI) Parental History of Diabetes	% (95% CI) Junior High School Education or More	% (95% CI) Current Cigarette Smoker	Mean (95% CI) Physical Activity, MET-h/wk	Mean (95% CI) Body Mass Index,	Mean (95% CI) Waist Circumference, cm	Mean (95% CI) Systolic Blood Pressure, mm Hg
Overall	98 658	5.6 (5.4-5.8)	62.4 (62.0-62.7)	28.3 (27.9-28.6)	87.3 (86.5-88.2)	23.7 (23.7-23.8)	80.2 (80.1-80.3)	131.7 (131.5-131.9)
Sex								
Men	45 143	5.6 (5.3-5.9)	69.9 (69.3-70.4)	53.3 (52.7-53.9)	94.6 (93.2-96.0)	23.8 (23.7-23.8)	82.1 (82.0-82.3)	133.3 (133.1-133.6)
Women	53 515	5.6 (5.4-5.9)	54.6 (54.1-55.2)	2.5 (2.3-2.6)	79.8 (78.7-80.8)	23.7 (23.6-23.7)	78.3 (78.1-78.4)	130.0 (129.8-130.3)
Location								
Urban	38 928	9.1 (8.7-9.4)	75.8 (75.3-76.3)	27.9 (27.3-28.5)	66.8 (65.7-67.8)	24.1 (24.1-24.2)	81.7 (81.6-81.9)	131.3 (131.0-131.5)
Rural	59 730	4.0 (3.8-4.2)	56.3 (55.7-56.8)	28.4 (28.0-28.9)	96.6 (95.5-97.8)	23.5 (23.5-23.6)	79.5 (79.4-79.7)	131.9 (131.7-132.1)
Age groups, y								
18-29	14 710	4.5 (4.1-4.9)	87.3 (86.6-88.0)	24.6 (23.7-25.5)	72.7 (70.6-74.8)	22.5 (22.5-22.6)	76.4 (76.2-76.6)	120.8 (120.4-121.1)
30-39	18 008	6.9 (6.4-7.4)	70.0 (69.2-70.8)	29.8 (28.9-30.6)	95.5 (93.5-97.6)	23.8 (23.8-23.9)	80.0 (79.8-80.2)	125.2 (124.9-125.5)
40-49	24 990	7.6 (7.2-8.0)	64.4 (63.7-65.2)	31.1 (30.4-31.9)	103.2 (101.4-105.0)	24.5 (24.4-24.5)	81.9 (81.7-82.0)	131.4 (131.1-131.7)
50-59	20 966	6.1 (5.7-6.4)	48.6 (47.7-49.4)	31.3 (30.5-32.1)	98.6 (96.8-100.5)	24.4 (24.3-24.4)	82.5 (82.3-82.6)	139.7 (139.3-140.0)
60-69	12 809	3.6 (3.3-4.0)	30.2 (29.2-31.1)	27.8 (26.9-28.8)	81.2 (79.1-83.3)	24.1 (24.0-24.2)	82.3 (82.1-82.6)	147.1 (146.6-147.6)
≥70	7175	1.5 (1.2-1.9)	17.4 (16.4-18.4)	21.6 (20.4-22.8)	47.5 (45.5-49.5)	23.5 (23.3-23.6)	81.5 (81.2-81.8)	152.4 (151.7-153.1)
Economic development								
Underdeveloped	29 082	3.2 (2.9-3.5)	53.9 (53.1-54.6)	28.3 (27.6-29.0)	107.1 (105.4-108.9)	23.2 (23.2-23.3)	78.6 (78.5-78.8)	130.2 (129.9-130.5)
Intermediately developed	34 742	5.0 (4.7-5.3)	60.6 (59.9-61.3)	28.7 (28.0-29.3)	86.4 (84.9-87.8)	23.6 (23.6-23.7)	79.9 (79.8-80.1)	131.8 (131.5-132.1)
Developed	34 834	8.7 (8.3-9.0)	72.8 (72.2-73.3)	27.8 (27.2-28.4)	68.0 (66.9-69.1)	24.3 (24.3-24.4)	82.1 (82.0-82.3)	133.1 (132.8-133.3)
BMI[a]								
<25.0	63 956	4.5 (4.3-4.8)	62.2 (61.7-62.7)	28.9 (28.5-29.4)	90.8 (89.7-92.0)	21.7 (21.7-21.7)	75.6 (75.5-75.7)	127.8 (127.6-128.0)
25.0-29.9	28 971	7.4 (7.0-7.8)	62.6 (61.9-63.3)	27.2 (26.5-27.9)	81.8 (80.3-83.2)	27.0 (26.9-27.0)	88.1 (88.0-88.2)	138.5 (138.2-138.8)
≥30.0	5646	9.6 (8.6-10.6)	62.5 (60.9-64.1)	25.0 (23.4-26.6)	71.8 (68.6-74.9)	32.6 (32.5-32.7)	98.0 (97.7-98.4)	145.4 (144.6-146.2)
Waist circumference, cm[a]								
<90 in men; <80 in women	62 189	4.6 (4.4-4.8)	64.5 (64.0-65.0)	32.1 (31.6-32.6)	76.5 (75.3-77.8)	22.2 (22.1-22.2)	75.0 (75.0-75.1)	127.9 (127.7-128.1)
≥90 in men; ≥80 in women	36 394	7.6 (7.3-8.0)	57.9 (57.2-58.5)	20.5 (19.9-21.0)	92.6 (91.5-93.7)	26.9 (26.9-27.0)	90.9 (90.8-91.0)	139.6 (139.3-139.8)

Abbreviation: MET, metabolic equivalent.

[a] There were 85 missing values for body mass index (BMI), which is calculated as weight in kilograms divided by height in meters squared, and 75 missing values for waist circumference.

(95% CI, 3.4%-3.6%) for those with previously diagnosed diabetes: 3.6% (95% CI, 3.4%-3.8%) in men and 3.4% (95% CI, 3.2%-3.5%) in women. Among the 3 glycemic parameters, a 2-hour plasma glucose concentration of 200 mg/dL or higher was less frequent (3.5%; 95% CI, 3.4%-3.7%) than fasting plasma glucose concentration of 126 mg/dL or higher (4.5%; 95% CI, 4.4%-4.7%) or an HbA_{1c} concentration of 6.5% or more (4.6%; 95% CI, 4.4%-4.7%) among individuals without a history of diabetes (Table 3 and eTables 2 and 3 in the Supplement). The prevalence of diabetes was higher in urban than in rural residents in both men and women (Table 3 and **Figure**). Furthermore, diabetes prevalence increased with age in both men and women (*P* value for trend <.001), and men younger than 50 years had a higher prevalence, whereas women older than 60 years had a higher prevalence (Figure). In addition, the prevalence of diabetes increased with economic development, as well as in overweight and obese persons (Table 3, Figure).

The estimated prevalence of prediabetes was 50.1% (95% CI, 49.7%-50.6%) in Chinese adults: 52.1% (95% CI, 51.5%-52.7%) in men and 48.1% (95% CI, 47.6%-48.7%) in women (**Table 4**). The prevalence estimated by 2-hour plasma glucose alone was much lower than by either fasting plasma glu-

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Table 2. Metabolic Risk Factors of Chinese Adult Population

	Mean (95% CI), mg/dL						
	Cholesterol						
	Total	Low-Density Lipoprotein	High-Density Lipoprotein	Triglycerides	Fasting Plasma Glucose	2-Hour Plasma Glucose	Hemoglobin A_{1c}, Mean (95% CI), %
Overall	157.5 (157.2-157.9)	88.6 (88.3-88.8)	42.7 (42.6-42.8)	122.2 (121.2-123.2)	100.5 (100.3-100.7)	112.3 (111.9-112.7)	5.8 (5.8-5.8)
Sex							
Men	157.9 (157.4-158.5)	89.5 (89.2-89.9)	41.4 (41.3-41.6)	133.3 (131.6-135.0)	101.5 (101.2-101.8)	110.7 (110.2-111.3)	5.8 (5.8-5.8)
Women	157.1 (156.7-157.6)	87.5 (87.2-87.9)	44.1 (43.9-44.2)	110.7 (109.7-111.7)	99.4 (99.2-99.7)	113.9 (113.4-114.4)	5.8 (5.7-5.8)
Location							
Urban	160.0 (159.4-160.5)	91.7 (91.3-92.1)	42.5 (42.3-42.6)	125.2 (123.7-126.7)	102.8 (102.5-103.1)	114.2 (113.6-114.8)	5.8 (5.8-5.8)
Rural	156.4 (156.0-156.9)	87.1 (86.8-87.4)	42.8 (42.7-42.9)	120.8 (119.5-122.1)	99.4 (99.2-99.6)	111.4 (111.0-111.9)	5.8 (5.7-5.8)
Age groups, y							
18-29	143.7 (142.9-144.5)	79.9 (79.3-80.4)	41.8 (41.5-42.0)	102.3 (100.2-104.3)	94.6 (94.2-95.0)	100.9 (100.2-101.6)	5.6 (5.5-5.6)
30-39	153.1 (152.3-153.8)	85.7 (85.2-86.2)	42.0 (41.8-42.2)	122.5 (120.0-125.0)	97.4 (97.1-97.8)	106.3 (105.6-107.1)	5.6 (5.6-5.7)
40-49	160.8 (160.1-161.5)	90.3 (89.9-90.8)	42.7 (42.5-42.9)	133.7 (131.5-135.9)	101.5 (101.1-101.9)	113.0 (112.2-113.7)	5.8 (5.8-5.8)
50-59	169.0 (168.3-169.8)	95.8 (95.2-96.3)	43.9 (43.7-44.1)	135.7 (133.4-138.1)	105.5 (105.0-106.0)	120.4 (119.5-121.4)	6.0 (6.0-6.0)
60-69	168.8 (167.9-169.8)	96.3 (95.6-96.9)	43.7 (43.5-44.0)	127.3 (125.0-129.7)	107.0 (106.3-107.6)	127.8 (126.5-129.1)	6.1 (6.1-6.1)
≥70	168.4 (167.2-169.7)	95.8 (94.9-96.7)	44.2 (43.8-44.6)	118.8 (116.5-121.1)	106.6 (105.7-107.5)	133.2 (131.4-135.0)	6.1 (6.0-6.1)
Economic development							
Underdeveloped	156.9 (156.3-157.5)	87.1 (86.6-87.5)	43.0 (42.8-43.2)	120.4 (118.6-122.2)	98.7 (98.4-99.1)	112.2 (111.5-112.9)	5.8 (5.8-5.8)
Intermediately developed	154.7 (154.2-155.3)	87.3 (86.9-87.7)	42.5 (42.3-42.6)	121.0 (119.3-122.8)	99.4 (99.1-99.7)	110.2 (109.6-110.8)	5.7 (5.7-5.8)
Developed	161.0 (160.5-161.6)	91.4 (91.0-91.8)	42.7 (42.5-42.9)	125.1 (123.5-126.7)	103.3 (103.0-103.6)	114.6 (114.0-115.2)	5.8 (5.8-5.8)
BMI[a]							
<25.0	153.2 (152.7-153.6)	84.8 (84.5-85.1)	44.3 (44.2-44.4)	102.2 (101.3-103.1)	98.0 (97.8-98.3)	107.3 (106.9-107.7)	5.7 (5.7-5.7)
25.0-29.9	165.9 (165.2-166.5)	95.8 (95.3-96.2)	39.7 (39.5-39.9)	159.0 (156.5-161.4)	104.8 (104.4-105.2)	121.2 (120.5-122.0)	5.9 (5.9-5.9)
≥30.0	169.6 (168.0-171.1)	98.7 (97.7-99.7)	38.4 (38.0-38.7)	182.6 (176.4-188.8)	108.4 (107.3-109.6)	131.5 (129.5-133.5)	6.1 (6.1-6.1)
Waist circumference, cm[a]							
<90 in men; <80 in women	152.9 (152.5-153.3)	84.9 (84.6-85.2)	43.9 (43.8-44.0)	105.1 (104.1-106.2)	97.9 (97.7-98.1)	106.6 (106.2-107.0)	5.7 (5.7-5.7)
≥90 cm in men; ≥80 in women	167.1 (166.5-167.7)	96.1 (95.7-96.5)	40.3 (40.2-40.5)	157.2 (155.1-159.3)	105.7 (105.3-106.1)	124.4 (123.6-125.1)	6.0 (6.0-6.0)

SI conversion factors: To convert plasma glucose to mmol/L, multiply by 0.0555; total, low-density lipoprotein, and high-density lipoprotein cholesterol to mmol/L multiply by 0.0259; and triglycerides to mmol/L, multiply by 0.0113.

[a] There were 85 missing values for body mass index (BMI), which is calculated as weight in kilograms divided by height in meters squared, and 75 missing values for waist circumference.

cose or HbA_{1c} alone (eTables 2 and 4 in the Supplement). Rural residents had slightly higher prevalence of prediabetes than did urban residents, especially in men (Figure). The prevalence of prediabetes increased with age (*P* value for trend <.001), and was higher in men younger than 50 years (Figure). Additionally, prediabetes was more prevalent in economically underdeveloped regions, as well as in overweight and obese persons (Table 4, Figure).

The proportion of diabetes patients who were aware of their condition was 30.1% (95% CI, 29.1%-31.1%) among the Chinese general population: 29.7% (95% CI, 28.3%-31.2%) in men and 30.5% (95% CI, 29.1%-31.9%) in women. Only 25.8% (95% CI, 24.9%-26.8%) of overall patients with diabetes were treated for this condition: 25.5% (95% CI, 24.2%-26.9%) in men and 26.2% (95% CI, 24.9%-27.5%) in women. Among those treated, 39.7% (95% CI, 37.6%-41.8%) had their HbA_{1c} controlled to a concentration of less than 7.0%: 40.7% (95% CI, 37.6%-43.7%) in men and 38.6% (95% CI, 35.9%-41.3%) in women (**Table 5**, eTable 5 in the Supplement). The proportions of those who were aware of, treated for, and managed their glucose levels were higher in urban than in rural residents and higher in economically developed and intermediately developed regions

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Table 3. Estimated Prevalence of Diabetes Among Chinese Adults

	Estimated Prevalence (95% CI), %[a]								
		Plasma Glucose							
	Total Diabetes	Fasting ≥126 mg/dL	2-Hour ≥200 mg/dL	HbA_{1c} ≥6.5%	Fasting ≥126 and/or 2-Hour ≥200 mg/dL	Fasting ≥126 mg/dL and/or HbA_{1c} ≥6.5%	2-Hour ≥ 200 mg/dL and/or HbA_{1c} ≥6.5%	Fasting ≥126, 2-Hour ≥200 mg/dL, and/or HbA_{1c} ≥6.5%	Previously Diagnosed Diabetes
Overall	11.6 (11.3-11.8)	4.5 (4.4-4.7)	3.5 (3.4-3.7)	4.6 (4.4-4.7)	6.2 (6.0-6.4)	6.9 (6.7-7.2)	6.2 (6.0-6.4)	8.1 (7.9-8.3)	3.5 (3.4-3.6)
Sex									
Men	12.1 (11.7-12.5)	5.0 (4.7-5.2)	3.8 (3.5-4.0)	4.6 (4.4-4.9)	6.6 (6.4-6.9)	7.3 (7.0-7.6)	6.4 (6.1-6.7)	8.5 (8.2-8.8)	3.6 (3.4-3.8)
Women	11.0 (10.7-11.4)	4.0 (3.8-4.3)	3.3 (3.1-3.5)	4.5 (4.3-4.7)	5.7 (5.4-6.0)	6.6 (6.3-6.9)	6.0 (5.7-6.2)	7.7 (7.4-8.0)	3.4 (3.2-3.5)
Location									
Urban	14.3 (13.9-14.8)	5.0 (4.8-5.3)	4.1 (3.8-4.3)	5.3 (5.0-5.5)	6.8 (6.5-7.1)	7.7 (7.3-8.0)	7.0 (6.7-7.3)	8.8 (8.5-9.1)	5.6 (5.3-5.8)
Rural	10.3 (10.0-10.6)	4.3 (4.1-4.5)	3.3 (3.1-3.5)	4.3 (4.0-4.5)	5.9 (5.7-6.2)	6.6 (6.4-6.9)	5.8 (5.6-6.1)	7.8 (7.5-8.1)	2.5 (2.4-2.7)
Age groups, y									
18-29	4.5 (4.1-5.0)	2.1 (1.8-2.5)	1.3 (1.0-1.6)	2.1 (1.8-2.4)	2.7 (2.3-3.1)	3.4 (3.0-3.9)	2.7 (2.3-3.1)	3.8 (3.4-4.2)	0.7 (0.6-0.9)
30-39	6.6 (6.1-7.1)	3.2 (2.9-3.6)	2.0 (1.8-2.3)	2.6 (2.4-3.0)	4.0 (3.6-4.4)	4.4 (4.0-4.8)	3.6 (3.2-3.9)	5.1 (4.7-5.5)	1.5 (1.3-1.8)
40-49	11.3 (10.8-11.8)	5.0 (4.7-5.4)	3.4 (3.1-3.7)	4.4 (4.1-4.8)	6.5 (6.1-6.9)	7.1 (6.7-7.5)	5.9 (5.5-6.3)	8.1 (7.7-8.6)	3.2 (2.9-3.4)
50-59	17.6 (17.0-18.3)	6.4 (6.0-6.9)	5.1 (4.7-5.5)	7.1 (6.7-7.5)	8.7 (8.2-9.2)	10.3 (9.7-10.8)	9.3 (8.8-9.8)	11.8 (11.2-12.3)	5.9 (5.5-6.2)
60-69	22.5 (21.6-23.4)	7.0 (6.4-7.5)	6.9 (6.4-7.5)	8.6 (8.0-9.3)	10.5 (9.9-11.2)	11.8 (11.1-12.6)	11.6 (10.9-12.3)	14.1 (13.4-14.9)	8.3 (7.8-8.9)
≥70	23.5 (22.3-24.7)	7.7 (6.9-8.5)	8.2 (7.4-9.0)	8.3 (7.5-9.2)	12.4 (11.5-13.4)	12.2 (11.2-13.2)	12.7 (11.7-13.7)	15.5 (14.4-16.6)	8.0 (7.3-8.8)
Economic development									
Underdeveloped	9.9 (9.5-10.4)	4.2 (3.9-4.5)	3.3 (3.0-3.6)	4.5 (4.2-4.9)	5.8 (5.4-6.1)	6.7 (6.3-7.0)	6.1 (5.7-6.4)	7.9 (7.5-8.3)	2.1 (1.9-2.3)
Intermediately developed	10.5 (10.1-11.0)	3.9 (3.7-4.2)	3.2 (3.0-3.5)	4.1 (3.8-4.3)	5.6 (5.3-5.9)	6.2 (5.9-6.5)	5.6 (5.3-5.9)	7.3 (7.0-7.7)	3.2 (3.0-3.4)
Developed	14.3 (13.9-14.7)	5.5 (5.2-5.8)	4.1 (3.8-4.3)	5.1 (4.9-5.4)	7.2 (6.8-7.5)	8.0 (7.6-8.4)	6.9 (6.6-7.2)	9.1 (8.7-9.5)	5.2 (4.9-5.5)
BMI									
<25.0	8.3 (8.0-8.6)	3.2 (3.1-3.4)	2.4 (2.2-2.5)	2.9 (2.7-3.1)	4.5 (4.3-4.7)	4.9 (4.7-5.1)	4.2 (4.0-4.4)	5.9 (5.6-6.1)	2.4 (2.3-2.5)
25.0-29.9	17.0 (16.5-17.6)	6.6 (6.2-6.9)	5.3 (5.0-5.7)	7.1 (6.7-7.5)	8.8 (8.4-9.2)	10.1 (9.7-10.6)	9.2 (8.8-9.6)	11.5 (11.1-12.0)	5.5 (5.2-5.8)
≥30.0	24.5 (23.1-26.0)	9.9 (9.0-11.0)	8.4 (7.5-9.4)	12.8 (11.7-13.9)	13.3 (12.1-14.5)	16.6 (15.4-17.9)	15.2 (14.0-16.5)	18.1 (16.9-19.5)	6.3 (5.6-7.1)
Waist circumference, cm									
<90 in men; <80 in women	7.9 (7.6-8.2)	3.2 (3.0-3.3)	2.2 (2.1-2.4)	2.7 (2.5-2.8)	4.4 (4.2-4.6)	4.7 (4.5-4.9)	4.0 (3.8-4.1)	5.7 (5.4-5.9)	2.2 (2.1-2.4)
≥90 in men; ≥80 in women	19.1 (18.6-19.6)	7.3 (7.0-7.7)	6.2 (5.8-6.5)	8.5 (8.1-8.9)	9.8 (9.4-10.2)	11.6 (11.1-12.0)	10.7 (10.3-11.2)	13.0 (12.6-13.5)	6.0 (5.8-6.3)

Abbreviations: BMI, body mass index (BMI) is calculated as weight in kilograms divided by height in meters squared; HbA_{1c}, hemoglobin A_{1c}.

SI conversion factor: To convert plasma glucose to mmol/L, multiply by 0.0555.

[a] Data are weighted percentages.

than in underdeveloped regions. Women living in rural areas had a substantially lower proportion of controlled diabetes than did their male counterparts or than did women living in urban areas (Table 5). Similarly, women living in underdeveloped regions had a much lower control rate than men living in the same regions or women living in intermediately developed or developed regions.

In the multivariable, multinomial, logit models, male sex; older age; urban residency; parental history of diabetes; overweight; obesity; central obesity; elevated systolic blood pressure; and elevated serum total cholesterol, LDL-cholesterol, and triglyceride levels were all significantly associated with a higher risk of diabetes (**Table 6**). Current cigarette smoking, alcohol consumption, higher serum HDL-cholesterol level, and living in intermediately developed regions were associated with a lower risk of diabetes. In addition, male sex, older age, parental history of diabetes, overweight, obesity, central obesity, physical activity, elevated systolic blood pressure, and elevated serum total cholesterol were positively associated with a higher risk

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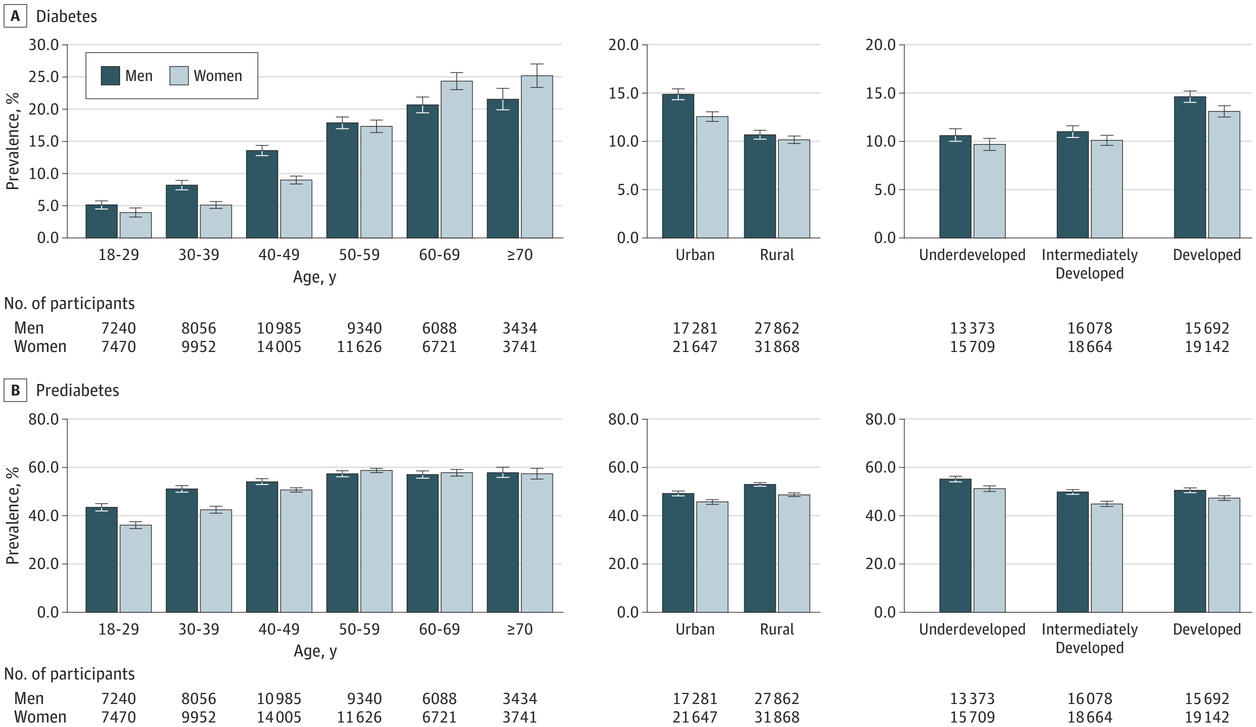
Figure. Age-Specific and Age-Standardized Prevalence of Diabetes and Prediabetes in Chinese Adults Aged 18 Years or Older in 2010



Error bars indicate 95% confidence intervals.

of prediabetes. Higher education, higher serum HDL-cholesterol and triglycerides levels, and living in intermediately developed and developed regions were inversely associated with prediabetes (Table 6).

Discussion

This large national survey documents that diabetes has become a major public health problem in the general population of China. Our study estimated that approximately 11.6% of Chinese adults 18 years or older may have had diabetes in 2010. In addition, the weighted results suggest that half of the entire Chinese adult population (50.1%) may have had prediabetes, which is an important risk factor for the development of overt diabetes and cardiovascular disease.[15,16] Furthermore, among patients with diabetes, it is estimated that less than one-third (30.1%) were aware of their condition and only one-quarter (25.8%) reported receiving treatment for diabetes. Moreover, only little more than one-third of patients (39.7%) treated for diabetes had adequate glycemic control. These data suggest that diabetes may have reached an alert level in the Chinese general population, with the potential for a major epidemic of diabetes-related complications, including cardiovascular disease, stroke, and chronic kidney disease in China in the near future without an effective national intervention.

The prevalence of diabetes was estimated to be 8.3% worldwide in 2012, representing a total of 371 million people living with diabetes.[17] The prevalence of diabetes in Asian populations has increased rapidly in recent decades with a disproportionate burden among young and middle-aged individuals.[18] It was estimated that the national prevalence of diabetes was 9.0% in India.[17] Our study and a previous study by Yang et al[5] indicate that China is now among the countries with the highest diabetes prevalence in Asia and has the largest absolute disease burden of diabetes in the world. Projections from our study estimate that 113.9 million Chinese adults 18 years or older (60.5 million men and 53.4 million women) may have had diabetes and 493.4 million (260.1 million men and 233.3 million women) may have had prediabetes in 2010. The estimated prevalence of diabetes in the Chinese population is very similar to the US population (11.3%) even though overweight and obesity are much more common in the United States.[19,20] The mean BMI was 23.7 in our study vs 28.7 in the US population.[20] In addition, it has been suggested that poor nutrition in utero and early life combined with overnutrition in later life may contribute to the accelerated epidemic of diabetes in China.[21]

Diabetes is a major risk factor for morbidity and mortality worldwide.[22] High blood glucose levels accounted for 21% of all deaths from ischemic heart disease and 13% of all deaths from stroke worldwide with 84% of these cardiovascular deaths in low- and middle-income countries.[23] Diabetes is the most common underlying cause for chronic kidney disease.[24] Diabetic retinopathy is the leading cause of blindness in working-age adults in many countries.[25,26] Furthermore, recent studies have reported that diabetes is a risk factor for cancer.[27-30]

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Table 4. Estimated Prevalence of Prediabetes Among Chinese Adults

	Estimated Prevalence (95% CI), %[a]						
		Plasma Glucose					
	Total Prediabetes	Fasting 100-125 mg/dL	2-Hour 140-199 mg/dL	HbA_{1c} 5.7%-6.4%	Fasting 100-125 mg/dL and/or 2-Hour 140-199 mg/dL	Fasting 100-125 mg/dL and/or HbA_{1c} 5.7%-6.4%	2-Hour 140-199 mg/dL and/or HbA_{1c} 5.7%-6.4%
Overall	50.1 (49.7-50.6)	27.2 (26.8-27.6)	8.3 (8.1-8.5)	35.4 (35.0-35.8)	31.0 (30.6-31.4)	48.3 (47.9-48.7)	38.7 (38.3-39.1)
Sex							
Men	52.1 (51.5-52.7)	29.0 (28.5-29.6)	7.9 (7.6-8.2)	36.3 (35.8-36.9)	32.5 (32.0-33.1)	50.4 (49.7-51.0)	39.7 (39.1-40.3)
Women	48.1 (47.6-48.7)	25.3 (24.8-25.8)	8.7 (8.4-9.1)	34.4 (33.8-34.9)	29.4 (28.9-29.9)	46.2 (45.7-46.8)	37.6 (37.1-38.2)
Location							
Urban	48.4 (47.8-49.1)	28.0 (27.5-28.6)	8.3 (7.9-8.6)	33.6 (33.1-34.2)	31.4 (30.8-31.9)	46.9 (46.3-47.5)	36.8 (36.2-37.3)
Rural	50.9 (50.4-51.4)	26.8 (26.4-27.3)	8.3 (8.0-8.6)	36.2 (35.7-36.7)	30.8 (30.4-31.3)	49.0 (48.4-49.5)	39.5 (39.0-40.1)
Age groups, y							
18-29	40.1 (39.0-41.1)	21.4 (20.5-22.3)	4.4 (4.0-4.9)	25.1 (24.2-26.0)	23.8 (22.9-24.7)	38.6 (37.6-39.7)	27.4 (26.5-28.4)
30-39	47.1 (46.2-48.0)	26.0 (25.2-26.8)	6.2 (5.7-6.6)	30.6 (29.7-31.4)	28.9 (28.1-29.8)	45.3 (44.4-46.2)	33.7 (32.8-34.6)
40-49	52.6 (51.9-53.4)	29.8 (29.1-30.6)	8.9 (8.4-9.3)	36.7 (35.9-37.4)	33.8 (33.0-34.5)	50.7 (49.9-51.5)	40.4 (39.6-41.2)
50-59	58.2 (57.4-59.1)	31.7 (30.9-32.5)	10.2 (9.7-10.8)	44.8 (44.0-45.6)	35.8 (35.0-36.6)	56.5 (55.6-57.3)	48.3 (47.5-49.2)
60-69	57.7 (56.6-58.8)	29.6 (28.6-30.6)	12.9 (12.2-13.7)	45.5 (44.4-46.6)	35.3 (34.3-36.4)	55.5 (54.4-56.6)	49.6 (48.5-50.6)
≥70	58.1 (56.7-59.5)	29.6 (28.3-31.0)	16.1 (15.1-17.3)	46.5 (45.0-47.9)	37.4 (36.0-38.8)	55.7 (54.2-57.2)	50.8 (49.4-52.3)
Economic development							
Underdeveloped	53.2 (52.4-53.9)	26.1 (25.4-26.7)	8.5 (8.1-8.9)	39.5 (38.8-40.3)	30.2 (29.6-30.9)	51.2 (50.4-52.0)	42.9 (42.1-43.6)
Intermediately developed	47.7 (47.0-48.4)	25.3 (24.7-25.9)	7.8 (7.4-8.1)	33.3 (32.7-34.0)	29.2 (28.6-29.8)	45.9 (45.2-46.6)	36.5 (35.9-37.2)
Developed	49.5 (48.8-50.2)	30.3 (29.7-30.9)	8.6 (8.3-9.0)	33.2 (32.6-33.8)	33.6 (33.0-34.2)	47.9 (47.2-48.5)	36.5 (35.9-37.2)
BMI[b]							
<25.0	48.1 (47.6-48.6)	25.3 (24.8-25.7)	6.9 (6.7-7.2)	33.2 (32.7-33.7)	28.7 (28.2-29.1)	46.3 (45.8-46.8)	36.3 (35.8-36.8)
25.0-29.9	54.3 (53.5-55.0)	31.1 (30.4-31.8)	10.6 (10.2-11.1)	39.5 (38.7-40.2)	35.5 (34.8-36.2)	52.4 (51.6-53.1)	43.2 (42.5-44.0)
≥30.0	54.6 (52.8-56.3)	31.3 (29.7-32.9)	13.4 (12.3-14.7)	41.0 (39.3-42.7)	36.8 (35.1-38.5)	52.5 (50.7-54.2)	45.0 (43.2-46.7)
Waist circumference, cm							
<90 in men; <80 in women	48.5 (47.9-49.0)	25.7 (25.2-26.1)	6.9 (6.6-7.1)	33.2 (32.8-33.7)	29.0 (28.6-29.5)	46.7 (46.1-47.2)	36.4 (35.9-36.9)
≥90 in men; ≥80 in women	53.6 (52.9-54.2)	30.3 (29.7-31.0)	11.3 (10.9-11.7)	39.7 (39.1-40.4)	35.0 (34.4-35.7)	51.7 (51.0-52.4)	43.4 (42.7-44.1)

Abbreviation: HbA_{1c}, hemoglobin A_{1c}.

SI conversion factor: To convert plasma glucose to mmol/L, multiply by 0.0555.

[a] Data are weighted percentages.

[b] Body mass index (BMI) is calculated as weight in kilograms divided by height in meters squared.

Improvement in glycemic control is the key for preventing diabetes-related complications.[31] Our study indicates that the awareness, treatment, and control rates of diabetes in the general Chinese population may be disproportionately low, raising concern for future high rates of diabetes-related morbidity and mortality.

Our study used the most current 2010 ADA criteria, which include an HbA_{1c} concentration of 6.5% or higher for the diagnosis of diabetes and may have partly contributed to the increased prevalence. When the 1999 World Health Organization criteria were used, both our study and the one in 2007[5] found similar prevalence estimates (9.7%). Nevertheless, with rapid economic growth and associated industrialization, urbanization, and lifestyle changes (increased high-calorie, high-fat, high-sugar, and high-sodium diets and decreased physical activity), prediabetes and diabetes have reached epidemic proportions in the Chinese population. Moreover, the prevalence of prediabetes was high in the younger age groups, which may translate into a greater epidemic of diabetes in the near future. A diabetes epidemic would further burden an already

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Table 5. Awareness, Treatment, and Control of Diabetes Among Chinese Adults

	Percentage (95% CI),%								
	Overall[a]			Men[a]			Women[a]		
	Awareness	Treatment	Control	Awareness	Treatment[b]	Control	Awareness	Treatment	Control
Overall	30.1 (29.1-31.1)	25.8 (24.9-26.8)	39.7 (37.6-41.8)	29.7 (28.3-31.2)	25.5 (24.2-26.9)	40.7 (37.6-43.7)	30.5 (29.1-31.9)	26.2 (24.9-27.5)	38.6 (35.9-41.3)
Location									
Urban	38.7 (37.2-40.3)	32.7 (31.3-34.2)	40.8 (38.1-43.5)	38.7 (36.5-40.9)	32.6 (30.5-34.7)	39.5 (35.7-43.6)	38.8 (36.7-40.9)	32.9 (31.0-35.0)	42.2 (38.7-45.9)
Rural	24.6 (23.3-25.9)	21.5 (20.3-22.7)	38.6 (35.6-41.7)	23.8 (22.0-25.7)	20.9 (19.2-22.7)	41.8 (37.2-46.4)	25.5 (23.7-27.3)	22.1 (20.5-23.8)	35.4 (31.5-39.4)
Age groups, y									
18-29	15.8 (12.7-19.6)	13.5 (10.6-17.1)	56.3 (43.6-68.2)	17.6 (13.2-23.1)	16.0 (11.8-21.4)	58.9 (42.8-73.2)	13.4 (9.5-18.5)	10.1 (6.8-14.8)	50.6 (31.4-69.5)
30-39	23.0 (20.1-26.3)	19.4 (16.6-22.5)	42.9 (34.7-51.4)	23.3 (19.4-27.7)	19.8 (16.1-24.0)	43.4 (32.6-54.9)	22.6 (18.4-27.4)	18.8 (14.9-23.3)	42.0 (30.7-54.1)
40-49	27.9 (25.9-30.0)	23.8 (21.9-25.9)	38.0 (33.5-42.6)	29.2 (26.5-32.1)	25.3 (22.6-28.1)	40.3 (34.4-46.4)	25.9 (23.0-29.0)	21.6 (19.0-24.5)	33.8 (27.4-40.9)
50-59	33.2 (31.4-35.1)	28.3 (26.6-30.2)	37.3 (33.8-41.0)	33.1 (30.4-35.9)	27.7 (25.1-30.3)	37.8 (32.6-43.4)	33.3 (30.9-35.9)	29.1 (26.7-31.6)	36.8 (32.1-41.7)
60-69	37.1 (35.0-39.4)	32.8 (30.8-35.0)	38.9 (35.2-42.8)	35.4 (32.2-38.7)	30.6 (27.5-33.8)	39.4 (33.4-45.6)	38.7 (35.8-41.6)	34.8 (32.0-37.7)	38.6 (34.0-43.5)
≥70	34.2 (31.5-36.9)	29.0 (26.5-31.6)	39.8 (34.9-45.0)	34.8 (30.8-39.0)	30.2 (26.4-34.4)	37.2 (30.1-44.9)	33.7 (30.2-37.4)	28.1 (24.9-31.6)	41.9 (35.3-48.8)
Economic development									
Underdeveloped	20.7 (19.0-22.6)	17.6 (16.0-19.3)	35.6 (30.8-40.8)	20.9 (18.4-23.5)	17.5 (15.2-20.0)	39.8 (32.6-47.5)	20.6 (18.2-23.1)	17.7 (15.5-20.0)	30.9 (25.0-37.5)
Intermediately developed	30.5 (28.8-32.4)	26.3 (24.7-28.1)	37.8 (34.2-41.5)	28.7 (26.2-31.3)	24.9 (22.6-27.4)	37.4 (32.2-42.9)	32.7 (30.2-35.3)	28.0 (25.6-30.5)	38.1 (33.4-43.2)
Developed	36.4 (34.8-37.9)	31.3 (29.8-32.8)	42.5 (39.7-45.4)	36.8 (34.6-39.1)	31.7 (29.5-33.9)	42.9 (38.8-47.2)	35.8 (33.7-38.0)	30.9 (28.9-32.9)	42.1 (38.4-45.8)
BMI									
<25.0	29.0 (27.6-30.5)	24.7 (23.4-26.1)	40.4 (37.3-43.5)	28.4 (26.4-30.5)	24.3 (22.5-26.3)	40.6 (36.2-45.2)	29.7 (27.6-31.8)	25.1 (23.2-27.1)	40.1 (36.0-44.3)
25.0-29.9	32.4 (30.9-34.0)	28.0 (26.6-29.5)	38.9 (35.9-41.9)	32.4 (30.2-34.7)	27.8 (25.7-30.0)	40.1 (35.8-44.7)	32.5 (30.4-34.7)	28.3 (26.3-30.3)	37.5 (33.6-41.6)
≥30.0	25.9 (23.3-28.8)	22.6 (20.1-25.4)	40.1 (33.7-46.8)	25.1 (21.0-29.6)	21.8 (17.9-26.2)	43.4 (33.1-54.2)	26.7 (23.3-30.4)	23.4 (20.1-26.9)	37.2 (29.6-45.5)
Waist circumference. cm									
<90 in men; <80 in women	28.2 (26.7-29.7)	23.8 (22.4-25.2)	42.9 (39.6-46.2)	28.6 (26.8-30.5)	24.1 (22.4-25.9)	43.0 (38.9-47.2)	27.3 (24.8-29.8)	23.0 (20.8-25.4)	42.6 (37.2-48.2)
≥90 in men; ≥80 in women	31.7 (30.4-33.0)	27.6 (26.3-28.9)	37.4 (34.8-40.0)	31.3 (29.1-33.5)	27.5 (25.4-29.6)	37.8 (33.5-42.4)	32.0 (30.4-33.7)	27.7 (26.2-29.3)	37.0 (34.0-40.2)

Abbreviation: BMI, body mass index, which is calculated as weight in kilograms divided by height in meters squared.

[a] *Awareness* was defined as the proportion of individuals who reported a history of physician-diagnosed diabetes among all patients with diabetes. *Treatment* was defined as the proportion of individuals taking diabetes medications among all patients with diabetes. *Control* was defined as the proportion of individuals with a hemoglobin A_{1c} level of less than 7.0% among patients with diabetes who were treated with diabetes medications.

[b] Data are weighted percentages.

overloaded health care system in China. The health care costs for diabetes would likely become a huge financial burden to patients, their families, and society as whole.[32] To avoid this societal burden, the primary prevention of diabetes should be a national priority for China.

Our study found that the prevalence of diabetes was lower but prediabetes was higher in underdeveloped regions. The reason for this is unclear but suggests that preventive interventions for diabetes should be used at all levels of economic development.

The present study has several strengths. First, it was conducted in a large nationally representative sample of the general population in China. Second, all 3 glycemic indexes for the diagnosis of diabetes—fasting plasma glucose, 2-hour plasma glucose, and HbA_{1c} concentrations—were obtained, which provide a comprehensive estimation of diabetes prevalence and control in the Chinese population. In addition, a strict quality assurance and quality control program was implemented at every phase of the study to ensure data validity and reliability.

There are also several study limitations. First, the capillary blood sample, instead of venous blood, was used for HbA_{1c} measurement. Because venous blood could be preserved in EDTA tubes for fewer than 7 days prior to HbA_{1c} measurement, the Hemoglobin Capillary Collection System was the best method for collecting blood samples in remote areas for centralized analysis. Excellent agreement between capillary and venous HbA_{1c} values (R^2 = 0.987) has been documented,[33] and

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Table 6. Risk Factors for Diabetes and Prediabetes in Chinese Adults[a]

Risk Factors[b]	Diabetes, OR (95% CI)	*P* Value	Prediabetes, OR (95% CI)	*P* Value
Male sex	1.52 (1.40-1.64)	<.001	1.23 (1.16-1.29)	<.001
Age per 10 y	1.55 (1.51-1.59)	<.001	1.26 (1.24-1.28)	<.001
Urban residency	1.15 (1.08-1.23)	<.001	0.99 (0.94-1.03)	.56
Parental history of diabetes	2.59 (2.32-2.88)	<.001	1.11 (1.02-1.21)	.01
≥Junior high school education	1.02 (0.95-1.09)	.55	0.91 (0.87-0.95)	<.001
Current smoking	0.84 (0.77-0.91)	<.001	0.95 (0.90-1.01)	.09
Current drinking	0.86 (0.79-0.92)	<.001	1.02 (0.97-1.07)	.38
Weight[c]				
Overweight	1.31 (1.21-1.41)	<.001	1.19 (1.12-1.25)	<.001
Obesity	2.03 (1.78-2.32)	<.001	1.52 (1.37-1.70)	<.001
Central obesity	1.64 (1.51-1.77)	<.001	1.17 (1.11-1.24)	<.001
Physical activity per 105 MET-h/wk	0.99 (0.96-1.02)	.53	1.06 (1.04-1.08)	<.001
Systolic blood pressure per 22 mm Hg	1.47 (1.42-1.52)	<.001	1.17 (1.14-1.20)	<.001
Cholesterol				
Total per 43 mg/dL	1.65 (1.47-1.85)	<.001	1.61 (1.46-1.76)	<.001
Low-density lipoprotein per 31 mg/dL	1.10 (1.01-1.20)	.03	0.97 (0.91-1.04)	.46
High-density lipoprotein per 12 mg/dL	0.70 (0.66-0.73)	<.001	0.79 (0.76-0.82)	<.001
Triglycerides per 118 mg/dL	1.12 (1.07-1.18)	<.001	0.93 (0.89-0.97)	.002
Intermediately developed vs underdeveloped	0.80 (0.74-0.87)	<.001	0.77 (0.74-0.81)	<.001
Developed vs underdeveloped	1.00 (0.92-1.09)	.93	0.89 (0.84-0.94)	<.001

Abbreviation: OR, odds ratio.

SI conversion factors: To convert total, low-density lipoprotein, and high-density lipoprotein cholesterol to mmol/L, multiply by 0.0259; triglycerides to mmol/L, multiply by 0.0113.

[a] There were 1432 missing values for status of glucose regulation, 4 missing values for current smoking, 85 missing values for body mass index and 75 missing values for waist circumference.

[b] Numbers for continuous variables are values of 1 standard deviation.

[c] *Overweight* was defined as a body mass index (BMI), which is calculated as weight in kilograms divided by height in meters squared, of 25.0-29.9 and *obesity* was defined as a BMI of 30.0 or higher. *Central obesity* was defined as waist circumference 90 cm or more in men and 80 cm or more in women.

a validated formula was available to convert capillary HbA_{1c} into venous values. Second, we did not distinguish between type 1 and type 2 diabetes in this study. Nevertheless, type 2 diabetes is the predominant form of diabetes in adults.[34] In addition, due to the cross-sectional nature of our study and potential reverse causation bias, associations between some risk factors and diabetes or prediabetes were in unexpected directions. Finally, participation after the initial invitation varied by province, with lower initial acceptance in urban than in rural provinces. These differences could have differentially affected prevalence estimates in urban and rural environments.

The estimated prevalence of diabetes and prediabetes in a representative sample of Chinese adults was 11.6% and 50.1%, respectively. Projections based on sample weighting suggest this may represent up to 113.9 million and 493.4 million adults, respectively. These findings indicate the importance of diabetes as a public health problem in China.

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