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Prevalence and Treatment of Diabetes in China, 2013-2018

Limin Wang, MPH; Wen Peng, MD, MPH; Zhenping Zhao, MPH; Mei Zhang, PhD; Zumin Shi, MD, PhD; Ziwei Song, BA; Xiao Zhang, PhD; Chun Li, MS; Zhengjing Huang, MS; Xiaomin Sun, PhD; Linhong Wang, PhD; Maigeng Zhou, PhD; Jing Wu, PhD; Youfa Wang, MD, PhD

IMPORTANCE Recent data on prevalence, awareness, treatment, and risk factors of diabetes in China is necessary for interventional efforts.

OBJECTIVE To estimate trends in prevalence, awareness, treatment, and risk factors of diabetes in China based on national data.

DESIGN, SETTING, AND PARTICIPANTS Cross-sectional nationally representative survey data collected in adults aged 18 years or older in mainland China from 170 287 participants in the 2013-2014 years and 173 642 participants in the 2018-2019 years.

EXPOSURES Fasting plasma glucose and hemoglobin A_{1c} levels were measured for all participants. A 2-hour oral glucose tolerance test was conducted for all participants without diagnosed diabetes.

MAIN OUTCOMES AND MEASURES Primary outcomes were diabetes and prediabetes defined according to American Diabetes Association criteria. Secondary outcomes were awareness, treatment, and control of diabetes and prevalence of risk factors. A hemoglobin A_{1c} level of less than 7.0% (53 mmol/mol) among treated patients with diabetes was considered adequate glycemic control.

RESULTS In 2013, the median age was 55.8 years (IQR, 46.4-65.2 years) and the weighted proportion of women was 50.0%; in 2018, the median age was 51.3 years (IQR, 42.1-61.6 years), and the weighted proportion of women was 49.5%. The estimated prevalence of diabetes increased from 10.9% (95% CI, 10.4%-11.5%) in 2013 to 12.4% (95% CI, 11.8%-13.0%) in 2018 ($P < .001$). The estimated prevalence of prediabetes was 35.7% (95% CI, 34.2%-37.3%) in 2013 and 38.1% (95% CI, 36.4%-39.7%) in 2018 ($P = .07$). In 2018, among adults with diabetes, 36.7% (95% CI, 34.7%-38.6%) reported being aware of their condition, and 32.9% (95% CI, 30.9%-34.8%) reported being treated; 50.1% (95% CI, 47.5%-52.6%) of patients receiving treatment were controlled adequately. These rates did not change significantly from 2013. From 2013 to 2018, low physical activity, high intake of red meat, overweight, and obesity significantly increased in prevalence.

CONCLUSIONS AND RELEVANCE In this survey study, the estimated diabetes prevalence was high and increased from 2013 to 2018. There was no significant improvement in the estimated prevalence of adequate treatment.

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Author Affiliations: Author affiliations are listed at the end of this article.

Corresponding Authors: Jing Wu, PhD, National Center for Chronic and Noncommunicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention, No. 27 Nanwei Rd, Xicheng District, 100050 Beijing, China (wujing@chinacdc.cn); Youfa Wang, MD, PhD, Global Health Institute, Xi'an Jiaotong University Health Science Center, Room 3104, No. 21 Hongren Building, West China Science and Technology Innovation Harbour (iHarbour), 710061 Xi'an, Shaanxi, China (youfawang@gmail.com).

Prevention and control of noncommunicable diseases is a public health priority worldwide. However, data have shown steady increases in noncommunicable diseases, especially obesity and diabetes, in many countries.[1-4] Diabetes prevalence in China increased from less than 1% in the 1980s to almost 11% in 2013.[5-9] In 2013, China reported having the largest number of patients with diabetes and spending the second highest amount on diabetes and its complications worldwide.[8,10,11] In addition, the population of patients with prediabetes represents a large reservoir of patients at risk of diabetes. Previous research showed low rates of awareness, treatment, and control of diabetes in China,[6-8] compared with the United States.[12] Previous national surveillance data described the prevalence and treatment of diabetes in China in 2013.[8] Another survey reported estimated diabetes prevalence of 11.2% and prediabetes prevalence of 35.2% in 2015.[13]

The prevalence, awareness, and treatment of diabetes varies within populations.[3,7,8,14] Socioeconomic and behavioral factors (eg, diet, smoking) may account for this variation. Behavioral factors are important modifiable factors for diabetes prevention and management. China has launched public health campaigns to promote healthful behaviors, including tobacco control, healthful diet, and physical activity. To our knowledge, no nationally representative studies with consistent study design have comprehensively investigated trends in the prevalence, treatment, and risk factors of diabetes in China.

Using nationally and provincially representative data collected in the 2013-2014 and 2018-2019 survey cycles in China, this study aimed to describe time trends in prevalence of diabetes and prediabetes, awareness and treatment of diabetes, and risk factors associated with diabetes.

Key Points

Question What is the prevalence of diabetes and prediabetes and diabetes treatment in China?

Findings In this nationally representative cross-sectional study conducted in mainland China with 173 642 participants in 2018, the estimated overall prevalence of diabetes was 12.4% and of prediabetes was 38.1%, with awareness of diabetes in 36.7%, treatment in 32.9%, and adequate control in 50.1%. Among the 170 287 participants enrolled in 2013, the estimated prevalence of diabetes was 10.9% and of prediabetes was 35.7%.

Meaning Estimated diabetes prevalence in China increased significantly from 2013 to 2018, with a low estimated prevalence of adequate treatment.

Methods

Study Design

The China Chronic Disease and Risk Factors Surveillance is an ongoing, periodic, nationally representative, cross-sectional study initiated in 2004 to monitor the prevalence of major noncommunicable diseases and their risk factors in China. It is organized by the Chinese Center for Disease Control and Prevention. The 2 latest nationally and provincially representative surveys were conducted with identical methods from June 2013 to May 2014 and August 2018 to June 2019. Results from the 2013 survey were published previously.[8] The study protocols were approved by the Chinese Center for Disease Control and Prevention ethical review committee and other participating institutes. Written informed consent was obtained from all participants.

The multistage stratified sampling framework and study protocols for the 2 surveys were described previously.[7,8,15] The response rates were 93.4% in 2013 and 96.8% in 2018 (eTable 1 in the Supplement). Noninstitutionalized participants aged 18 years or older who had been living at their current residence for at least 6 months within the year before the survey were enrolled. Pregnant women were excluded.[8]

Data Collection

The survey included questionnaire interviews, anthropometric measurements, and blood sample collection and measurement. Questionnaires including demographic characteristics, medical history, and socioeconomic and behavioral factors were administered by trained interviewers. Trained staff in local community clinics measured height using mechanical anthropometry stadiometers (Bengbu Equipment), weight using electronic body scales with regular calibration, and waist circumference using torch shape measuring tape (Foshan Equipment).

Plasma glucose was measured after an overnight fast for every participant and at 2 hours after a 75-g oral glucose tolerance test among participants without a self-reported diabetes history. Plasma glucose was measured using hexokinase methods according to the protocol at 290 sites and using standardized glucose oxidase in 8 sites, within 24 hours of sample collection. A web-based quality monitoring system for plasma glucose measurement was applied.[16] Hemoglobin A_{1c} (HbA_{1c}) was measured using venous blood samples within 4 weeks of blood collection with quantitative high-performance liquid chromatography and the boronate affinity method (Bio-Rad D-10 Hemoglobin Analyzer) at the central laboratory. All these procedures followed a standard protocol.[7,8,15]

Covariates and Diabetes Risk Factors

Sociodemographic and lifestyle characteristics and related risk factors were self-reported in face-to-face interviews, including data on ethnicity, education (<middle school, ≥middle school), smoking status (current smoker, former smoker, nonsmoker), excessive alcohol consumption (alcohol consumption of 15 g/d or greater for women and 25 g/d or greater for men), low physical activity (<150 minutes/week), low fruit and vegetable intake (<400 g/d), and high red meat intake (≥100 g/d). Ethnicity was obtained using fixed categories and was cross-checked with the participant's identification card by the interviewer (**Table 1**).

Underweight was defined as body mass index (BMI) of less than 18.5; normal weight, 18.5 to 23.9; overweight, 24 to 27.9, and obesity, 28 or higher, according to the Chinese national standard.[17] Central obesity was defined as waist circumference of 90 cm or greater for men and 85 cm or greater for women.[18]

Health Outcomes

Primary outcomes were prevalence of diabetes and prediabetes according to American Diabetes Association criteria.[19] Diabetes was defined as participants with self-reported diabetes diagnosed by a health professional or with a fasting plasma glucose level of 126 mg/dL or greater, a 2-hour plasma glucose level of 200 mg/dL or greater after a 75-g oral glucose challenge, or HbA_{1c} level of 6.5% or greater. Prediabetes was defined as participants who did not have diabetes but who had a fasting plasma glucose of 100 to 125 mg/dL, a 2-hour plasma glucose of 140-199 mg/dL, or HbA_{1c} level of 5.7% to 6.4%. (To convert glucose from mg/dL to mmol/L, multiply by 0.0555; HbA_{1c}, from percentage to mmol/mol, subtract 2.15 and multiply by 10.929. BMI is calculated as weight in kilograms divided by height in meters squared.)

Secondary outcomes were awareness, treatment, and control rates of diabetes and risk factors for diabetes. Awareness rate was defined as the proportion of individuals with self-reported, physician-diagnosed diabetes among all patients with diabetes. For participants who reported having diabetes, they were asked about the use of oral diabetic medication, insulin use, dietary change, and physical activity as measures to manage the condition. Among all patients with diabetes, the treatment rate was defined as the proportion of individuals receiving diabetes treatment, including oral medication, insulin, dietary management, and increased

Table 1. General Characteristics and Potential Risk Factors of Diabetes in Chinese Adults in the 2013-2014 and 2018-2019 Surveys[a]

	Chinese adults, No. (%)					
	2018			2013		
	All	Men	Women	All	Men	Women
All	173 642 (100.0)	76 726 (50.0)	96 916 (50.0)	170 287 (100.0)	72 736 (50.5)	97 551 (49.5)
Age, y						
Median (IQR)	51.3 (42.1-61.6)	55.0 (44.3-64.5)	53.4 (43.9-63.0)	55.8 (46.6-65.2)	55.0 (44.3-64.5)	53.4 (43.9-63.0)
18-29	9046 (24.7)	3877 (24.7)	5169 (24.7)	13 486 (25.1)	6475 (25.1)	7011 (25.1)
30-39	17 173 (20.5)	6995 (20.7)	10 178 (20.2)	21 980 (20.3)	9397 (20.5)	12 583 (20.2)
40-49	31 466 (22.1)	13 117 (22.2)	18 349 (22.1)	42 268 (22.1)	16 867 (22.2)	25 401 (21.9)
50-59	45 951 (15.6)	19 500 (15.7)	26 451 (15.6)	43 011 (15.4)	17 585 (15.6)	25 426 (15.3)
60-69	47 291 (9.7)	21 879 (9.8)	25 412 (9.6)	32 714 (9.6)	14 556 (9.7)	18 158 (9.6)
≥70	22 715 (7.4)	11 358 (7.0)	11 357 (7.8)	16 828 (7.4)	7856 (6.9)	8972 (8.0)
Socioeconomic status						
Education						
≤Primary school	86 187 (31.7)	32 013 (25.8)	54 174 (37.6)	82 154 (36.3)	29 010 (29.6)	53 144 (43.3)
Secondary school	52 822 (33.2)	27 432 (36.7)	25 390 (29.7)	53 216 (36.2)	26 366 (40.1)	26 850 (32.3)
High school	22 645 (17.6)	11 795 (20.0)	10 850 (15.1)	23 725 (17.0)	11 737 (19.3)	11 988 (14.7)
≥College or above	11 988 (17.5)	5486 (17.4)	6502 (17.6)	11 093 (10.4)	5574 (11.1)	5519 (9.8)
Household income per capita, yuan/y[b]						
No.	134 146	59 960	74 186	130 309	56 691	73 618
<16 000	32 668 (18.4)	15 290 (18.4)	17 378 (18.3)	32 481 (19.2)	14 488 (19.2)	17 993 (19.1)
16 000-<30 000	21 686 (13.9)	9688 (13.7)	11 998 (14.2)	25 847 (17.8)	10 924 (17.6)	14 923 (18.0)
30 000-<50 000	30 612 (22.3)	13 529 (22.3)	17 083 (22.2)	36 563 (29.0)	15 849 (28.7)	20 714 (29.3)
≥50 000	49 180 (45.4)	21 453 (45.5)	27 727 (45.3)	35 418 (34.0)	15 430 (34.5)	19 988 (33.6)
Urban residence[c]	70 790 (51.8)	29 790 (52.1)	41 000 (51.6)	78 317 (45.6)	31 793 (44.8)	46 524 (46.5)
Behavioral factors						
Never smoked	120 507 (69.1)	27 023 (40.8)	93 484 (97.4)	119 556 (67.8)	25 589 (38.9)	93 967 (97.3)
Current smoker	41 946 (26.0)	39 220 (50.1)	2726 (2.0)	41 515 (27.4)	38 609 (52.2)	2906 (2.3)
Past smoker	11 189 (4.8)	10 483 (9.1)	706 (0.5)	9118 (4.7)	8500 (8.9)	618 (0.5)
Excessive alcohol consumption[d]	15 146 (8.2)	13 754 (15.3)	1392 (1.1)	14 597 (9.3)	13 190 (17.2)	1407 (1.3)
<400 g/d of fruits or vegetables	79 450 (44.4)	35 540 (45.4)	43 910 (43.5)	80 529 (46.7)	34 889 (47.1)	45 640 (46.2)
≥100 g/d of red meat	62 980 (42.3)	32 488 (49.7)	30 492 (34.9)	50 822 (32.6)	25 767 (38.2)	25 055 (26.9)
<150 min/wk of exercise	33 839 (22.0)	16 736 (24.1)	17 103 (19.9)	24 291 (16.0)	12 314 (17.9)	11 977 (14.1)
Weight status						
Based on Chinese BMI standard						
Underweight (<18.5)	5104 (4.2)	2217 (3.8)	2887 (4.5)	5980 (4.5)	2583 (4.1)	3397 (4.9)
Normal (18.5-23.9)	75 659 (44.8)	33 694 (41.6)	41 965 (48.0)	78 716 (48.9)	34 509 (47.9)	44 207 (49.9)
Overweight (24-27.9)	64 690 (34.5)	28 862 (36.4)	35 828 (32.7)	59 958 (32.5)	25 522 (33.8)	34 436 (31.1)
Obesity (≥28)	28 189 (16.5)	11 953 (18.2)	16 236 (14.8)	25 633 (14.1)	10 122 (14.1)	15 511 (14.2)
Based on WHO BMI standard						
Underweight (<18.5)	5104 (4.2)	2217 (3.8)	2887 (4.5)	5980 (4.5)	2583 (4.1)	3397 (4.9)
Normal (18.5-24.9)	95 084 (55.2)	42 307 (51.8)	52 777 (58.6)	97 159 (59.0)	42 317 (58.4)	54 842 (59.7)
Overweight (25-29.9)	60 925 (32.8)	27 177 (35.8)	33 748 (29.8)	55 718 (30.1)	23 601 (31.4)	32 117 (28.8)
Obesity (≥30)	12 529 (7.9)	5025 (8.6)	7504 (7.2)	11 430 (6.4)	4235 (6.1)	7195 (6.6)
Central obesity (men ≥90 cm, women ≥85 cm)	69 296 (35.4)	28 413 (37.3)	40 883 (33.5)	61 612 (31.6)	24 065 (30.7)	37 547 (32.6)

(continued)

Table 1. General Characteristics and Potential Risk Factors of Diabetes in Chinese Adults in the 2013-2014 and 2018-2019 Surveys[a] (continued)

	Chinese adults, No. (%)					
	2018			2013		
	All	Men	Women	All	Men	Women
Ethnicity[e]						
Han	152 393 (91.1)	67 339 (91.3)	85 054 (90.9)	150 766 (91.5)	64 012 (91.9)	86 754 (91.1)
Tibetan	3247 (0.2)	1507 (0.2)	1740 (0.2)	3103 (0.3)	1328 (0.3)	1775 (0.4)
Zhuang	2288 (1.1)	942 (1.0)	1346 (1.2)	2081 (0.8)	798 (0.7)	1283 (0.9)
Manchu (Man)	2354 (2.0)	1017 (2.0)	1337 (1.9)	2106 (1.7)	893 (1.6)	1213 (1.9)
Uyghur (Wei)	2330 (0.9)	1039 (0.9)	1291 (0.9)	1929 (0.8)	1029 (0.9)	900 (0.8)
Hui (Muslim)	2496 (0.8)	1095 (0.7)	1401 (0.9)	2085 (0.6)	990 (0.6)	1095 (0.5)
Other	8534 (3.9)	3787 (3.8)	4747 (4.0)	8217 (4.3)	3686 (4.1)	4531 (4.4)

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

[a] No. of patients was the unweighted number of subcategories denominator; the percentages were weighted.

[b] In 2013, 39 496 participants refused to answer; in 2018, 39978 refused to answer or answered "do not know." Absolute values are presented for household income. Purchasing power parity: 1 US$ is equivalent to 4.2 Chinese ¥ in 2018.

[c] Urban and rural residents were defined by the participants' habitual residence, which was classified by the criteria by the National Bureau of Statistics.

[d] Excessive alcohol consumption was defined as alcohol consumption 15 g/d or more for women, or 25 g/d or more for men.

[e] Ethnicity was obtained using fixed categories and was cross-checked with the participants' identification card by the interviewer. Only ethnic groups with more than 2000 samples were listed. Other refers to other ethnicity groups in China apart from the ones listed.

physical activity. The control rate was defined as the proportion of individuals with an HbA_{1c} level of less than 7.0% among patients receiving diabetes treatment.

Statistical Analysis

National estimates of the prevalence of diabetes and prediabetes; rates of diabetes awareness, treatment, and control; and proportions of related risk factors were calculated. Sampling weights were used in the analyses to produce nationally representative estimates. Taylor series linearization with a complex sampling design and finite population correction was used to estimate 95% CIs. Unweighted estimates were provided for ethnicity because ethnicity was not considered in the multistage sampling design.

Linear regression models were used to test the change in prevalence between 2018 and 2013 (absolute % increase equals prevalence in 2018 minus prevalence in 2013). The Jackknife replicate method was used for calculating relative percentage increase between 2013 and 2018. Because the amount of missing data was very small, we did not conduct imputation calculations. Only participants with complete data on age, sex, residence, BMI, and diabetes-related health outcomes were included in models.

A 2-tailed *P* value of <.05 was considered statistically significant. Because of the potential for type I error due to multiple comparisons, findings for analyses of secondary end points should be interpreted as exploratory. Data were analyzed with SAS version 9.4 (SAS Institute Inc).

Results

The 2013 survey enrolled 179 347 participants and the 2018 survey enrolled 184 509 participants. After exclusion of 9060 participants in 2013 and 10 867 in 2018 who had incomplete records, the final analyses included 170 287 participants in 2013 and 173 642 in 2018.

The median age was 55.8 years (IQR, 46.4-65.2 years) in 2013 and 51.3 years (IQR, 42.1-61.6 years) in 2018 (Table 1). In 2018, 50.1% of Chinese men reported current smoking; 44.4% of adults reported low fruit and vegetable intake, 42.3% reported high red meat intake; and 22.0% reported low physical activity. More men than women were current smokers and had excessive alcohol drinking (*P* < .001). Based on Chinese BMI standards, 34.5% were overweight and 16.5% had obesity. In addition, 35.4% had central obesity.

The overall standardized prevalence estimates of diabetes increased significantly from 10.9% (95% CI, 10.4%-11.5%) in 2013 to 12.4% (95% CI, 11.8%-13.0%) in 2018 (*P* < .001) (**Table 2**). The estimated prevalence of prediabetes was 35.7% (95% CI, 34.2%-37.3%) in 2013 and 38.1% (95% CI, 36.4%-39.7%) in 2018 (*P* = .07) (**Table 3**). The combined prevalence of diabetes and prediabetes in 2018 was 50.5%. A minority of participants with diabetes were aware of the diagnosis at the time of the 2018 survey: 4.5% (95% CI, 4.2%-4.8%) of Chinese adults reported a previous diagnosis of diabetes. In both surveys, women had a significantly lower prevalence of diabetes and prediabetes than men: women, 10.2% (95% CI, 9.7%-10.7%) vs men 11.7% (95% CI, 11.0%-12.4%) in 2013 and 11.5% (95% CI, 10.8%-12.2%) vs 13.3% (95% CI, 12.6%-14.0%) in 2018 (*P* < .001). The prevalence of diabetes increased with age: 5.0% (95% CI, 4.0%-6.1%) for those aged 18 through 29 years and 20.7% (95% CI, 19.1%-22.3%) for those 79 years or older in 2013; 5.0% (95% CI, 3.9%-6.2%) for those aged 18 through 29 years and 27.3% (95% CI, 25.7%-28.9%) for those 70 years or older in 2018 (*P* < .001).

In 2018, among adults with diabetes, 36.7% (95% CI, 34.7%-38.6%) were aware of their diagnosis and 32.9% (95% CI, 30.9%-34.8%) were being treated with medication, dietary control, or increased activity. Of those receiving treatment for

Table 2. Weighted Prevalence of Diabetes Based on 4 Different Criteria in Chinese Adults in the 2013-2014 and 2018-2019 Surveys[a]

	Sample size		Prevalence of diabetes by diagnostic criteria (95% CI), %							
			FPG, 2-h PG, or HbA_{1c}[b]		Health professional diagnosis of FPG or 2-hour PG[c]		Health professional diagnosis of FPG[d]		Self-report[e]	
	2018	2013	2018[f]	2013[f]	2018[f]	2013[f]	2018[f]	2013[f]	2018[f]	2013[f]
All	173 642	170 287	12.4 (11.8-13.0)	10.9 (10.4-11.5)	11.9 (11.3-12.5)	10.4 (9.8-10.9)	9.6 (9.1-10.1)	8.6 (8.1-9.1)	4.5 (4.2-4.8)	4.0 (3.6-4.3)
Sex										
Men	76 726	72 736	13.3 (12.6-14.0)	11.7 (11.0-12.4)	12.9 (12.2-13.6)	11.1 (10.4-11.7)	10.3 (9.7-10.9)	9.2 (8.6-9.8)	4.4 (4.0-4.7)	3.9 (3.5-4.3)
Women	96 916	97 551	11.5 (10.8-12.2)	10.2 (9.7-10.7)	11.0 (10.3-11.6)	9.6 (9.1-10.2)	8.9 (8.4-9.5)	8.0 (7.5-8.4)	4.7 (4.4-5.1)	4.1 (3.7-4.4)
Age group, y										
18-29	9046	13 486	5.0 (3.9-6.2)	5.0 (4.0-6.1)	4.4 (3.4-5.4)	4.4 (3.6-5.3)	3.5 (2.5-4.4)	3.5 (2.8-4.2)	0.7 (0.3-1.2)	1.1 (0.7-1.5)
30-39	17 173	21 980	6.5 (5.9-7.1)	6.9 (6.3-7.6)	6.3 (5.6-6.9)	6.6 (5.9-7.2)	5.0 (4.5-5.6)	5.5 (4.9-6.1)	1.5 (1.2-1.8)	1.7 (1.3-2.0)
40-49	31 466	42 268	11.1 (10.5-11.8)	10.6 (9.9-11.2)	10.9 (10.2-11.6)	10.1 (9.5-10.8)	8.7 (8.1-9.3)	8.8 (8.2-9.4)	3.6 (3.2-4.0)	3.5 (3.1-3.9)
50-59	45 951	43 011	19.3 (18.4-20.1)	16.2 (15.5-16.9)	18.7 (17.9-19.6)	15.4 (14.6-16.1)	15.9 (15.2-16.6)	13.2 (12.5-13.8)	8.2 (7.7-8.7)	7.2 (6.7-7.7)
60-69	47 291	32 714	23.9 (22.9-24.9)	19.8 (18.8-20.7)	23.3 (22.3-24.3)	19.0 (18.1-19.9)	18.9 (18.0-19.8)	15.6 (14.7-16.5)	11.2 (10.6-11.9)	8.8 (8.1-9.6)
≥70	22 715	16 828	27.3 (25.7-28.9)	20.7 (19.1-22.3)	26.6 (24.9-28.2)	19.8 (18.2-21.4)	20.2 (18.9-21.5)	14.9 (13.6-16.1)	12.0 (11.1-13.0)	8.7 (7.7-9.7)
Residence										
Urban	70 790	78 317	13.1 (12.2-14.0)	12.6 (11.7-13.5)	12.7 (11.9-13.5)	12.0 (11.1-12.9)	10.4 (9.7-11.1)	10.2 (9.4-11.0)	5.2 (4.8-5.7)	5.4 (4.8-6.0)
Rural	102 852	91 970	11.6 (10.8-12.4)	9.5 (9.0-10.1)	11.1 (10.3-12.0)	8.9 (8.4-9.5)	8.8 (8.1-9.5)	7.2 (6.7-7.7)	3.8 (3.4-4.1)	2.8 (2.5-3.0)

Abbreviations: FPG, fasting plasma glucose; PG, postprandial glucose; HbA_{1c}, hemoglobin A_{1c}.

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

[a] Weighted prevalence was calculated to be representative of the Chinese population. The Taylor series linearization method was used to estimate variance and 95% CIs. Percentages was weighted using the same age and sex profile from the sixth census in China.

[b] Diabetes was defined if participants self-reported that they had been diagnosed by a health professional; had a fasting plasma glucose level of 126 mg/dL or greater, had a 2-hour plasma glucose level of 200 mg/dL or greater after a 75-g oral glucose challenge, or had a HbA_{1c} level of 6.5% (48 mmol/mol) or greater.

[c] Diabetes was defined if participants self-reported that they had been diagnosed by a health professional; had a fasting plasma glucose level of 126 mg/dL or greater, or had a 2-hour plasma glucose level of 200 mg/dL or greater after a 75-g oral glucose challenge.

[d] Diabetes was defined as participants with a fasting plasma glucose level of 126 mg/dL or greater.

[e] Diabetes was defined as participants with self-reported diabetes diagnosed by a health professional.

[f] See eTable2 in the Supplement for absolute percentage increases from 2013 to 2018 and 95% CIs.

Table 3. Weighted Prevalence of Prediabetes Based on 3 Different Diagnostic Criteria in Chinese Adults in the 2013-2014 and 2018-2019 Surveys[a]

	Sample size		Prevalence of prediabetes by diagnostic criteria (95% CI), %[b]					
			FPG, 2-h PG, or HbA_{1C}		FPG or 2-h PG		FPG	
	2018	2013	2018[c]	2013[c]	2018[c]	2013[c]	2018[c]	2013[c]
All	173 642	170 287	38.1 (36.4-39.7)	35.7 (34.2-37.3)	35.1 (33.3-36.9)	30.8 (29.1-32.6)	31.9 (29.9-33.8)	27.4 (25.6-29.3)
Sex								
Men	76 726	72 736	41.2 (39.3-43.0)	36.4 (34.7-38.1)	38.1 (36.2-40.0)	31.8 (29.9-33.6)	35.1 (33.0-37.1)	28.6 (26.6-30.6)
Women	96 916	97 551	34.9 (33.2-36.7)	35.0 (33.5-36.6)	32.1 (30.2-34.0)	29.9 (28.1-31.6)	28.7 (26.7-30.6)	26.2 (24.4-28.0)
Age group, y								
18-29	9046	13 486	27.3 (24.6-29.9)	26.2 (23.9-28.4)	25.8 (23.0-28.5)	23.0 (20.7-25.4)	22.3 (19.7-24.9)	20.2 (18.0-22.5)
30-39	17 173	21 980	34.2 (32.0-36.4)	32.1 (30.2-34.1)	31.8 (29.6-34.0)	28.8 (26.9-30.8)	28.2 (25.8-30.6)	25.4 (23.4-27.4)
40-49	31 466	42 268	40.3 (38.3-42.3)	37.8 (36.0-39.7)	37.4 (35.4-39.5)	32.8 (30.8-34.9)	34.2 (32.0-36.3)	29.4 (27.3-31.5)
50-59	45 951	43 011	45.8 (44.4-47.3)	42.0 (40.4-43.5)	41.3 (39.6-42.9)	35.3 (33.4-37.1)	38.8 (37.0-40.6)	32.0 (30.0-33.9)
60-69	47 291	32 714	47.6 (46.3-48.9)	45.2 (43.8-46.6)	43.1 (41.6-44.6)	37.7 (36.1-39.4)	40.5 (38.7-42.4)	33.9 (32.0-35.8)
≥70	22 715	16 828	48.9 (47.4-50.4)	46.5 (44.4-48.6)	44.7 (43.1-46.3)	38.4 (36.2-40.7)	40.8 (38.9-42.8)	33.5 (31.2-35.7)
Residence								
Urban	70 790	78 317	36.5 (34.2-38.8)	34.3 (32.3-36.2)	33.4 (31.0-35.9)	29.7 (27.6-31.9)	30.4 (27.9-33.0)	26.7 (24.4-29.0)
Rural	102 852	91 970	39.8 (37.7-41.9)	37.0 (35.1-38.8)	36.9 (34.6-39.2)	31.7 (29.7-33.8)	33.4 (30.8-35.9)	28.0 (25.8-30.2)

Abbreviations: FPG, fasting plasma glucose; HbA_{1c}, hemoglobin A_{1c}; PG, postprandial glucose.

[a] For an explanation of how weighted prevalence was calculated, see the Table 2 footnotes.

[b] For the definition of prediabetes based on HbA_{1c}, FPG, or 2-hour PG, see the Methods section.

[c] See eTable 3 in the Supplement for absolute percentage increases from 2013 to 2018.

diabetes, 50.1% (95% CI, 47.5%-52.6%) controlled it adequately (**Table 4**). No significant differences were observed between 2013 and 2018.

Women had a statistically significant higher awareness and treatment rates than did men in both surveys. In 2013, 39.8% (95% CI, 37.5%-42.2%) of women vs 33.5% (95% CI, 31.2%-35.9%) of men were aware of their diagnosis and 35.3% (95% CI, 33.0%-37.5%) vs 29.5% (95% CI, 27.4%-31.6%) were being treated. In 2018, 41.2% (95% CI, 38.8%-43.6%) of women vs 32.8% (95% CI, 30.7%-34.8%) of men were aware of their diagnosis and 37.0% (95% CI, 34.6%-39.5%) of women vs 29.3% (95% CI, 27.3%-31.2%) of men were being treated (all $P < .001$) (Table 4).

Between 2013 and 2018, urban residence and reported educational level increased significantly ($P < .001$) (**Table 5**). Current smoking decreased from 27.5% (95% CI, 26.7%-28.2%) in 2013 to 26.0% (95% CI, 25.1%-26.9%) in 2018 and excessive alcohol consumption decreased from 9.3% (95% CI, 8.8%-9.8%) in 2013 to 8.2% (95% CI, 7.6%-8.8%) in 2018. However, the prevalence of high red meat intake increased from 32.6% (95% CI, 30.5%-34.7%) in 2013 to 42.3% (95% CI, 40.1%-44.5%) in 2018; insufficient physical activity increased from 16.0% (95% CI, 14.8%-17.0%) in 2013 to 22.0% (95% CI, 20.3%-23.2%) in 2018 ($P < .001$); overweight increased significantly from 32.5% (95% CI, 31.7%-33.2%) in 2013 to 34.5% (95% CI, 33.8%-35.3%) in 2018; obesity increased from 14.1% (95% CI, 13.5%-14.8%) in 2013 to 16.5% (95% CI, 15.9%-17.1%) in 2018; and central obesity increased significantly from 31.6% (95% CI, 30.5%-32.8%) in 2013 to 35.4% (95% CI, 34.3%-36.5%) in 2018 ($P < .001$).

Discussion

In this survey study conducted in China, the estimated diabetes prevalence was high and increased significantly from 2013 to 2018. There was no significant improvement in the estimated prevalence of adequate treatment. The rates of awareness, treatment, and control of diabetes remained low from 2013 to 2018. The prevalence and treatment of diabetes varied significantly by sex, age group, and residence.

To our knowledge, this study provides, the most updated information about prevalence, treatment, and risk factors of diabetes in China, based on the largest sample size. The data were more recent and the sample size larger compared with another study that used data from 75 880 participants in 2015-2017.[13] Study protocols have been consistent since 2004[15] and thus the findings represent comparable data over time on noncommunicable diseases in China.

The updated prevalence estimate of diabetes among Chinese adults (12.4%) was higher than a global estimate (8.3% in 2019)[10] and an estimate for India (6.7% in 2016),[4] but lower than in the US (14.6% in 2018)[3] and South Korea (13.7% in 2016).[20] The high and increased diabetes prevalence; low and stagnated rates of awareness, treatment, and control; high overweight and obesity rates; and worsened reported lifestyle factors indicate that the health burden of diabetes and its complications is increasing in China. The burden may become further intensified by the large population with prediabetes, shifts in lifestyle factors, and increasing overweight and obesity prevalence. Over the past 2 decades, China has experienced a rapid increase in obesity,[15] with a projected overweight-obesity prevalence of 65.3% by 2030.[21] This is accompanied by the findings in this study of a high prevalence of adverse health-related behaviors, including smoking, insufficient physical activity, low fruit and vegetable intake, and high red meat intake.

The findings may be associated with many individual and contextual factors. These include prevalent behavioral factors like smoking, dietary intake, and sedentary lifestyle, as

Table 4. Weighted Awareness, Treatment, and Control Rates of Diabetes in Chinese Adults in the 2013-2014 and 2018-2019 Surveys[a]

	No. of people with diabetes		Prevalence of patients with diabetes (95% CI), %								
			Awareness[b]			Treatment[c]			Control among patients being treated[d]		
	2018	2013	2018	2013	Absolute change,%	2018	2013	Absolute change,%	2018	2013	Absolute change,%
All	30 609	24 174	36.7 (34.7 to 38.6)	36.5 (34.3 to 38.6)	0.2 (−2.4 to 2.8)	32.9 (30.9 to 34.8)	32.2 (30.2 to 34.2)	0.7 (−1.7 to 3.1)	50.1 (47.5 to 52.6)	49.5 (47.2 to 51.7)	0.7 (−2.9 to 4.2)
Sex											
Men	14 254	10 744	32.8 (30.7 to 34.8)	33.5 (31.2 to 35.9)	−0.8 (−3.6 to 2.1)	29.3 (27.3 to 31.2)	29.5 (27.4 to 31.6)	−0.2 (−2.9 to 2.4)	48.2 (45.1 to 51.3)	50.1 (47.3 to 52.9)	−1.9 (−6.2 to 2.3)
Women	16 355	13 430	41.2 (38.8 to 43.6)	39.8 (37.5 to 42.2)	1.3 (−1.6 to 4.3)	37.0 (34.6 to 39.5)	35.3 (33.0 to 37.5)	1.8 (−1.1 to 4.7)	51.9 (48.6 to 55.3)	48.8 (46.1 to 51.5)	3.1 (−1.2 to 7.5)
Age group, y											
18-29	310	618	14.6 (5.7 to 23.5)	21.6 (15.6 to 27.5)	−7.0 (−17.3 to 3.4)	12.8 (4.0 to 21.5)	18.3 (13.5 to 23.2)	−5.6 (−15.4 to 4.3)	64.0 (36.0 to 92.0)	57.1 (47.2 to 67.0)	6.9 (−23.0 to 36.8)
30-39	987	1395	22.9 (18.7 to 27.0)	23.8 (20.3 to 27.3)	−1.0 (−6.3 to 4.4)	19.6 (15.8 to 23.3)	21.4 (18.1 to 24.7)	−1.8 (−6.8 to 3.1)	55.7 (45.8 to 65.6)	55.4 (46.4 to 64.5)	0.3 (−13.1 to 13.6)
40-49	3330	4249	32.5 (29.7 to 35.2)	33.4 (30.7 to 36.0)	−0.9 (−4.4 to 2.6)	27.9 (25.3 to 30.5)	29.7 (27.1 to 32.2)	−1.7 (−5.1 to 1.6)	48.6 (43.3 to 53.8)	47.6 (42.9 to 52.3)	1.0 (−5.6 to 7.6)
50-59	8368	7154	42.5 (40.3 to 44.7)	44.3 (42.2 to 46.4)	−1.8 (−4.8 to 1.2)	38.9 (36.8 to 41.0)	39.0 (36.9 to 41.2)	−0.2 (−3.0 to 2.7)	47.2 (44.2 to 50.3)	46.9 (44.5 to 49.4)	0.3 (−3.9 to 4.5)
60-69	11 384	6878	46.9 (45.0 to 48.8)	44.6 (42.0 to 47.1)	2.3 (−0.7 to 5.4)	43.0 (41.2 to 44.9)	39.2 (36.9 to 41.6)	3.8 (1.1 to 6.5)	49.0 (46.6 to 51.5)	49.3 (46.5 to 52.1)	−0.3 (−3.6 to 3.0)
≥70	6230	3880	44.0 (41.5 to 46.5)	42.1 (38.5 to 45.8)	1.9 (−2.2 to 6.0)	39.4 (36.9 to 42.0)	37.3 (33.7 to 40.9)	2.1 (−1.7 to 6.0)	52.7 (49.6 to 55.8)	49.9 (45.1 to 54.7)	2.8 (−2.7 to 8.2)
Residence											
Urban	14 633	13 441	40.0 (36.7 to 43.3)	43.1 (40.4 to 45.7)	−3.1 (−6.9 to 0.8)	36.2 (33.0 to 39.5)	38.4 (35.9 to 41.0)	−2.2 (−6.0 to 1.6)	54.1 (50.8 to 57.3)	53.5 (50.6 to 56.4)	0.5 (−3.9 to 4.9)
Rural	15 976	10 733	32.6 (30.9 to 34.4)	29.1 (26.8 to 31.4)	3.5 (0.8 to 6.3)	28.8 (27.0 to 30.5)	25.2 (23.3 to 27.1)	3.6 (1.1 to 6.1)	44.1 (41.3 to 47.0)	42.5 (39.6 to 45.5)	1.6 (−2.8 to 6.0)

[a] For an explanation of how weighted prevalence was calculated, see the Methods section.

[b] The awareness rate was defined as the proportion of individuals with physician-diagnosed diabetes among all patients with diabetes.

[c] The treatment rate was defined as the proportion of individuals receiving insulin, taking diabetes medications, maintaining dietary control, or increasing activity among all patients with diabetes.

[d] The control rate was defined as the proportion of individuals with a hemoglobin A_{1c} level of less than 7.0% (53 mmol/mol) among patients with diabetes receiving diabetes treatment. The analysis used sampling weights to provide nationally representative estimates. (To convert hemoglobin A_{1c} from percentage to mmol/mol, subtract 2.15 and multiply by 10.929.)

Table 5. Prevalence of Risk Factors in Chinese Adults in the 2013-2014 and 2018-2019 Surveys[a]

	Prevalence (95% CI), %		
	2018	2013	Absolute change
Urban residence	51.9 (47.2 to 56.5)	45.6 (41.7 to 49.6)	6.4 (1.3 to 11.4)
Education ≥ middle school	68.3 (66.2 to 70.3)	63.7 (61.6 to 65.7)	4.6 (2.4 to 6.8)
Overweight and obesity (BMI >24)	51.0 (50.0 to 52.1)	46.6 (45.4 to 47.8)	4.5 (3.0 to 5.9)
Overweight (BMI 24-27.9)	34.5 (33.8 to 35.3)	32.5 (31.7 to 33.2)	2.0 (1.2 to 3.0)
Obesity (BMI ≥28)	16.5 (15.9 to 17.1)	14.1 (13.5 to 14.8)	2.4 (1.5 to 3.2)
Central obesity (men ≥90 cm, women ≥85 cm)	35.4 (34.3 to 36.5)	31.6 (30.5 to 32.8)	3.8 (2.3 to 5.2)
Current smoker	26.0 (25.1 to 26.9)	27.5 (26.7 to 28.2)	−1.5 (−2.6-0.4)
Excessive alcohol consumption[b]	8.2 (7.6 to 8.8)	9.3 (8.8 to 9.8)	−1.1 (−1.8-0.4)
Low physical activity <150 min/wk	22.0 (20.3 to 23.2)	16.0 (14.8 to 17.0)	6.0 (4.3 to 7.7)
High red meat intake ≥100 g/d	42.3 (40.1 to 44.5)	32.6 (30.5 to 34.7)	9.5 (7.0 to 12.0)
Low fruit or vegetable intake <400 g/d	44.4 (42.5 to 46.4)	46.7 (44.5 to 48.9)	−2.2 (−4.7 to 0.3)

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

[a] Weighted rates were calculated to be representative of the Chinese adults. The distributions of the risk factors were in the whole Chinese population.

[b] Excessive alcohol consumption was defined as alcohol consumption 15 g/d or more for women and 25 g/d or more for men.

well as an aging population, urbanization, psychosocial stress, environmental pollution, health illiteracy, and lack of optimal health care coverage and service.[15,21-24] Reasons for the urban-rural differences in the prevalence and treatment of diabetes require further investigation.[14,25] Potential explanations include environmental, socioeconomic, lifestyle, and policy factors.[8,26-29] Although diabetes was more prevalent among urban residents in China, the associated excess mortality was higher among rural residents.[25]

The findings of this study have important clinical and public health implications. Comprehensive actions are needed to address the national diabetes burden from health, economic, and social perspectives. The poor awareness, treatment, and control rates of diabetes in China suggest a critical time frame for action. The urban-rural and regional differences in diabetes prevalence and management suggest the need for population-specific tailored interventions to be more effective. The ongoing "Healthy China 2030" national campaigns,[30] started in 2016, provide opportunities to facilitate such interventions.

To address the increasing diabetes burden in China, translation and implementation studies are required to develop better integrated, tailored, and sustainable interventions. The complex barriers at multiple levels for improving risk factors for diabetes and its management need to be better understood. Periodic evaluation of how national programs and policies affect trends and patterns in diabetes may provide valuable insights.

Limitations

This study had several limitations. First, the cross-sectional data cannot be used to determine causal relationships. Second, self-reported variables, such as the physician diagnosed diabetes, treatment of diabetes, and lifestyle risk factors, are susceptible to response bias and to inaccuracy. Third, diabetes treatment and control rates used in this study were consistent with previous studies in China but defined differently than estimates from some other countries like the US, which may limit comparability. Fourth, the lack of a comprehensive dietary assessment limited studying the association of dietary intake with diabetes.

Conclusions

In this survey study, the estimated diabetes prevalence was high and increased from 2013 to 2018. There was no significant improvement in the estimated prevalence of adequate treatment.

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Correction: This article was corrected on March 15, 2022, to fix the symbol in the overweight and obesity row of Table 5 and to show the ranges of the overweight and obesity rows as subcategories.

Author Affiliations: National Center for Chronic and Noncommunicable Disease Control and Prevention, Chinese Center for Disease Control and Prevention, Beijing, China (Limin Wang, Zhao, M. Zhang, Song, X. Zhang, Li, Huang, Linhong Wang, Zhou, Wu); Nutrition and Health Promotion Center, Department of Public Health, Medical College, Qinghai University, Xining, China (Peng); Global Health Institute, Xi'an Jiaotong University, Xi'an, China (Peng, Sun, Y. Wang); State Key Laboratory of Plateau Ecology and Agriculture, Qinghai University, Xining, China (Peng); Human Nutrition Department, College of Health Sciences, QU Health, Qatar University, Doha, Qatar (Shi); School of Public Health, Xi'an Jiaotong University, Xi'an, China (Sun, Y. Wang); Clinical Research Center for Cardiovascular Diseases, The First Affiliated Hospital of Xi'an Jiaotong University, Xi'an, China (Y. Wang).

Author Contributions: Drs Limin Wang and Y. Wang had full access to all of the data in the study and take responsibility for the integrity of the study and the accuracy of the data analysis. Drs Limin Wang, Peng, and Zhao contributed equally.
Concept and design: Y. Wang, Limin Wang, Wu, Peng.
Acquisition of data or filed quality control: Limin Wang, Zhao, M. Zhang, X. Zhang, C. Li, Huang, Linhong Wang, Zhou, Wu.
Drafting of the manuscript: Peng, Limin Wang, Zhao, Y. Wang.
Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Zhao, M. Zhang, Song, Shi, Peng, Limin Wang, Y. Wang.
Interpretation of data: All authors
Administrative, technical, or material support: Y. Wang, Limin Wang, Wu.
Supervision: Y. Wang, Limin Wang, Wu.

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