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Original Article

Diabetes awareness, treatment, control rates and associated risk factors among Beijing residents in 2011: A cross-sectional survey

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Abstract

Objective: To examine the awareness, treatment and control rates of diabetes and identify their associated risk factors among Beijing residents.

Methods: A cross-sectional survey was conducted in 2011, using a stratified multistage cluster random sampling method to select a representative sample of 20,242 residents in Beijing aged 18−79 years. Diabetes was defined as fasting blood glucose (FBG) ≥7.0 mmol/L and/or history of diabetes and/or using insulin or hypoglycemic agents. All estimates of awareness, treatment and control rates were weighted by the 2010 Beijing Population Census data and the sampling scheme. Multivariate Logistic regression was used to identify factors associated with awareness, treatment and control rates.

Results: A total of 2061 (10.3%) participants were diagnosed as diabetes. The overall awareness, treatment and control rate among patients were 60.9%, 51.3% and 22.4%, respectively, while overall control rate among treated patients was 33.8%. These rates differed across subgroups. Women were more likely to be aware of diabetes status, receive treatment and have better glucose controlled than men (69.5% *vs.* 54.7% for awareness, 61.0% *vs.* 44.3% for treatment, and 27.6% *vs.* 18.6% for control, respectively). In addition, only 22.2% of treated patients had both FBG and hemoglobin A1c (HbA1c) controlled well. Multivariate Logistic regression suggested that old age, women, higher education and family history of diabetes were associated with higher awareness, treatment and control rates (All $P < 0.05$). Treated individuals living in rural ($OR = 0.67$(95% *CI*: 0.47−0.96)) or with dyslipidemia ($OR = 0.63$ (95%*CI*: 0.44−0.91)) had a lower diabetic control rate.

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Conclusions: Awareness, treatment and control rates of diabetes in Beijing were still low. A comprehensive intervention strategy on diabetes management and control is warranted.

Keywords: Diabetes; Hemoglobin A1c; Awareness; Treatment; Control

Introduction

Diabetes is a major risk factor for all-cause morbidity and mortality worldwide, and it is an important underlying cause for cardiovascular diseases, metabolic syndrome and kidney failure in adults, leading to huge burden of health care.[1−4] In recent decades, the prevalence of diabetes has remarkably increased and is projected to keep increasing, especially in developing countries.[5−9] In China, the prevalence of diabetes increased from 2.5% in 1994 to 11.6% in 2010, representing about 113.9 million diabetic patients in 2010.[6−10] Many clinical trials and epidemiologic studies have shown that improvement of glycemic control plays a crucial role in diabetes management,[11−13] and it is also beneficial to reduce diabetes-related complications, such as infections, diabetic foot syndrome and cognitive decline.[14−16] However, emerging data identified incredibly low awareness, treatment and control rates of diabetes in Chinese population.[7,17] Beijing, one of the most developed and populous cities in China, suffered from huge burden of health care from diabetes and its complications.[2,18] There are limited studies with respect to awareness, treatment and control rates of diabetes in Beijing and the existing studies were mostly conducted in certain population or district.[19−22] In 2005, the overall awareness, treatment and control rate in population from four districts of Beijing was 56.7%, 50.0% and 15.0%, respectively.[19] In order to prevent and control chronic diseases, the Chinese government has increased financial investment on health care and Beijing has implemented comprehensive measurements in recent years.[23] However it remains unknown if the awareness, treatment and control rates of diabetes in Beijing residents have improved.

At present, fasting blood glucose (FBG) remains the most common measurement for glycemic control in clinical practice in China. As a stable index reflecting average glucose level over several months veritably, hemoglobin A1c (HbA1c) is recommended to be a definitive and long-term indicator of control target for diabetic patients by the American Diabetes Association (ADA)[24] and China Diabetes Society (CDS).[25] Therefore, it also remains unknown how HbA1c are controlled among diabetic patients who achieved the glycemic control target according to FBG level (FBG < 7.0 mmol/L).

The aim of the current study was to estimate diabetes awareness, treatment and control rates and associated risk factors among residents in Beijing using a population-based cross-sectional study.

Material and methods

Study population

Beijing Chronic Diseases Survey 2011 was a cross-sectional study conducted during September to November 2011. The study was aimed to examine the prevalence and associated risk factors of chronic diseases in the resident population in Beijing. Details of the study design have been published previously.[26] In brief, study participants were adults aged 18−79 years and had been living in their current residence for ≥6 months in the past 12 months in Beijing. We used a multistage stratified cluster random sampling method to select participants from 18 districts and counties in Beijing. In each district/county, two different sampling frames were designed on the basis of participants' employment status. On-post participants, accounting for three fourths of all participants, were sourced from workplace with two-stage sampling method. First, two or three worksites from each district/county were selected using probability proportional to size sampling (PPS) method. Second, 100 participants were selected using systematic sampling at each worksite. For off-post and retired participants, four-stage sampling was designed to sample the participants from households. In the first stage, towns were drawn from each district/county using PPS method. In the second stage, one residential committee/village was selected from each sampled town. In the third stage, one group was randomly sampled from each residential committee/village. In the final stage, about 100 households were randomly sampled, and one individual from each

household was selected using Kish selection table. If the individual refused or was unavailable, a replacement household with similar composition was selected in the same neighborhood or village.

Among selected 22,130 adults, 20,297 (91.7%) agreed to participate in the study and 20,242 aged 18–79 years were eligible for the study, accounting for approximately 1/850 of the total Beijing resident population aged 18–79 years. After excluding those whose diabetic status could not be identified, who lacked of information on blood glucose level, hypoglycemic therapy and self-reported history of diabetes simultaneously, 19,939 participants were used to ascertain diabetic patients. Finally, a total of 2061 diabetic participants were included in the current analysis (Fig. 1).

The study was approved by both of the Ethical Review Board of Fuwai Hospital and Ethical Review Board of Beijing Center for Disease Control and Prevention. Written informed consent was obtained from each participant before the survey.

Data collection

A standard questionnaire was administered by trained staff to obtain information on demographic characteristics, personal and family medical history, and lifestyle risk factors. Family history of diabetes was identified if at least one parent or sibling had ever been diagnosed as diabetes. Smoking was defined as having smoked at least 100 cigarettes through one's lifetime. Alcohol drinking was defined as drinking at least 12 times in the past year. Physical activity was recorded as total of metabolic equivalents-hours (METs·hours) per week, collected by the modified International Physical Activity Questionnaire.[27] Anthropometric measurements were performed by trained staff according to a standard protocol. Body weight and height was measured in light indoor clothing to the nearest 0.1 kg and 0.1 cm, respectively. Body mass index (BMI) was calculated as weight in kilograms divided by height in square meters (kg/m^2). Overweight and obesity was defined as BMI of 24.0–27.9 kg/m^2, and 28.0 kg/m^2 or greater, respectively.[28] Abdominal obesity was defined as waist circumference (WC) of 90 cm or more in men and 80 cm or more in women. Three blood pressure measurements were collected in sitting position after resting for 5 minutes. Hypertension was defined as systolic blood pressure/diastolic blood pressure $\geq$140/90 mmHg and/or use of antihypertensive medication. Overnight fasting blood samples were taken at the field center and serum samples were frozen at −20 °C after centrifuged within 3 hours at the field center. Dyslipidemia was defined as total cholesterol $\geq$240 mg/dl and/or low-density lipoprotein cholesterol $\geq$160 mg/dl and/or high-density lipoprotein cholesterol <40 mg/dl and/or triglycerides $\geq$200 mg/dl and/or use of lipid-lowering agents.

Blood glucose measurement and diagnostic criteria

FBG was measured using glucose oxidase method within 20 days (HITACHI 7600 automatic biochemical

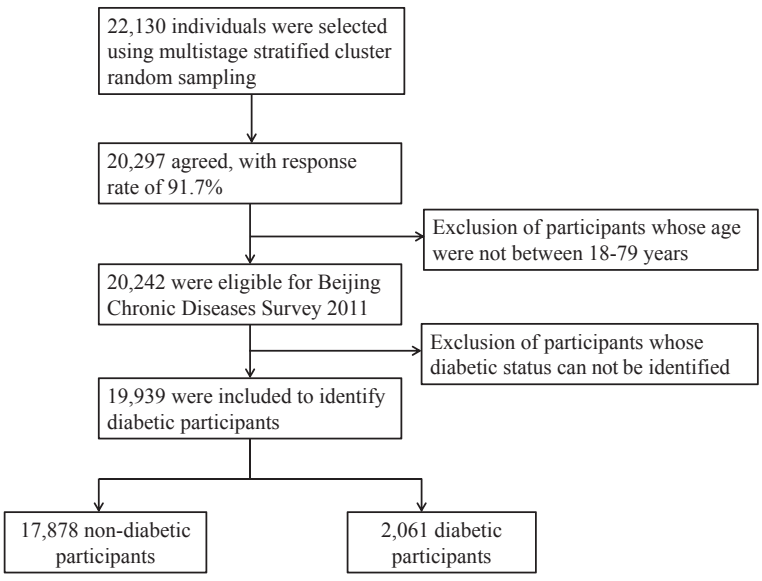

Fig. 1. Flow chart of the study sample showing inclusion and exclusion of participants.

analyzer, Hitachi High-Technologies, Corp., Japan). Serum HbA1c level was measured by high-performance liquid chromatography method (VARIANT II Hemoglobin Testing System, Bio-Rad Laboratories, Inc., USA) with up to 3 days storage at 2°C−8°C. All measurements were conducted according to a standard protocol by Beijing IPE Center for Clinical Laboratory, which completed a standardization and certification program.

Diabetes was defined as FBG $\geq$ 7.0 mmol/L and/or self-reported history of diabetes and/or using insulin or oral hypoglycemic agents. Awareness rate was defined as the proportion of persons with self-reported physician-diagnosed diabetes among those having diabetes. Treatment rate was defined as the proportion of persons taking hypoglycemic therapy among those having diabetes. Control was defined as FBG level of less than 7.0 mmol/L. We further evaluated long-term glycemic control, which was defined as HbA1c < 7.0%.

Statistical analysis

Awareness, treatment and control rates were weighted to represent the total Beijing population aged 18−79 years. The weights were calculated on the basis of the 2010 Beijing Population Census data[29] and the sampling scheme. Proportions and standard errors (SEs) for awareness, treatment and control rates were estimated in total participants and subgroups. Data were analyzed by SAS version 9.3 (SAS Institute, Inc., Cary, North Carolina, USA). PROC SURVEYMEANS and SURVEYFREQ were used for calculation of means and proportions, as well as corresponding standard errors, Rao-Scott chi square was used to test proportion difference among binary variables (sex, district, employment status, smoke, alcohol drinking, hypertension, dyslipidemia etc.) and SURVEYREG was used for linear trend test within age, education, income, physical activity and BMI. A multivariate Logistic regression was used to identify factors associated with diabetic awareness, treatment and control rates. All statistical tests were two-sided, and a P value <0.05 was considered statistically significant.

Results

Baseline characteristics of sampled participants

A total of 2061 (10.3%) participants were diagnosed as diabetes among 19,939 included residents in Beijing (Table 1). Diabetic patients were older (54.1 years) and more likely to be men (55.8%) than non-diabetic participants. The average level of FBG among diabetic and non-diabetic participants was 8.8 mmol/L and 5.1 mmol/L, while the average level of HbA1c among diabetic and non-diabetic participants was 7.9% and 5.7%, respectively. Besides, characteristics of diabetic participants and excluded participants, and characteristics of HbA1c status among those treated diabetic patients with FBG < 7.0 mmol/L are presented in Table 2 and Table 3, respectively.

Awareness, treatment and control rates of diabetes

Table 4 presents the awareness, treatment and control rates of diabetes by characteristics. Among all the diabetic patients in Beijing, 60.9% were aware of their condition, with 54.7% in men and 69.5% in women. As for treatment rate, the estimated proportion was 51.3% in Beijing adults, 44.3% in men and 61.0% in women. The control rate among treated patients was substantially higher than the control rate among all patients (33.8% *vs.* 22.4% for overall, 30.7% *vs.* 18.6% for men and 36.8% *vs.* 27.6% for women). In general, women had higher awareness, treatment and control rates than men among all diabetic patients, and women also tended to have a marginally significant higher control rate among treated patients than that in men. Both awareness rate and treatment rate increased with ages. Similar trend was also observed for the control rate among all patients (13.0% in 18−44 years, 22.9% in 45−59 years, and 27.5% in 60−79 years), however, no significant difference was observed for control rate among treated patients, with 25.5%, 35.3% and 34.1% in the 18−44, 45−69 and 60−79 years age groups, respectively. Compared with urban residents, rural residents had similar awareness and treatment rates but a relatively lower control rate among all patients and treated patients (61.7% *vs.* 60.3% for awareness, 52.2% *vs.* 50.7% for treatment, 19.2% *vs.* 24.4% for control among patients, and 27.8% *vs.* 37.7% for control among treated patients, respectively). Besides, the control rates among treated patients were lower among diabetic patients with dyslipidemia and smoking habits, and tended to be lower among overweight/obese or abdominal obese patients.

Long-term glycemic control among diabetic patients

Among FBG-controlled diabetic patients, an estimated 65.9% patients further had their HbA1c adequately controlled (<7.0%). However, only 22.2% of

all treated diabetic patients both had their FBG and HbA1c well controlled. Among treated diabetic patients, participants who were resident in rural, obese/abdominal obese, with dyslipidemia had significantly lower control rates (FBG < 7.0 mmol/L and HbA1c < 7.0%); while no significant differences were observed among subgroup populations by sex, age, employment status and blood pressure levels (Fig. 2).

Related factors associated with diabetic awareness, treatment and control

Several factors were observed to influence awareness, treatment and control rates of diabetes to some extent (Table 5). Among all patients, older age and family history of diabetes were significantly associated with higher diabetic awareness, treatment and control rates, while men and patients with low education level were substantially less aware of diabetes status, less likely to be treated and less to be FBG-controlled. For example, compared with men, women had about more than 50% increased proportions of diabetic awareness, treatment and control rates. The multivariate-adjusted odds ratio (*OR*) was 1.73 (95% confidence interval (*CI*): 1.22−2.46) for awareness, 1.52 (95%*CI*: 1.10−2.11) for treatment, and 1.81 (95%*CI*: 1.28−2.57) for control, respectively. In addition, among treated patients rural patients and patients with dyslipidemia were less likely to have controlled FBG levels, with the multivariate-adjusted *ORs* of 0.67 (95%*CI*: 0.47−0.96) and 0.63 (95%*CI*: 0.44−0.91), respectively.

Table 1
Characteristics of the sampled participants by diabetic status.[a]

Variables	Diabetes[b] (n = 2061)	Non-diabetes (n = 17,878)	Overall (n = 19,939)	P[c]
Age, years	54.1 ± 11.3	43.3 ± 13.1	44.4 ± 13.3	<0.001
Women	910 (44.2)	10,002 (56.0)	10,912 (54.7)	<0.001
Rural	658 (31.9)	6280 (35.1)	6938 (34.8)	0.004
Employed	1178 (57.2)	14,281 (79.9)	15,459 (77.5)	<0.001
Education, years				
<6	286 (13.9)	1249 (7.0)	1535 (7.7)	<0.001[e]
7−12	1341 (65.1)	10,047 (56.2)	11,388 (57.2)	
≥13	432 (21.0)	6571 (36.8)	7003 (35.2)	
Income, 10,000 yuan/year				
≤1.9	621 (31.9)	4467 (26.5)	5088 (27.1)	<0.001[e]
2.0−3.4	829 (42.5)	6862 (40.7)	7691 (40.9)	
≥3.5	499 (25.6)	5534 (32.8)	6033 (32.1)	
Smoke	849 (41.2)	5345 (29.9)	6194 (31.1)	<0.001
Alcohol drinking	778 (37.8)	5857 (32.8)	6635 (33.3)	<0.001
Physical activity, Mets·hour/week[d]	55.7 (28.0−98.0)	51.1 (24.3−91.7)	51.1 (24.9−92.0)	<0.001[f]
Family history of diabetes	808 (39.2)	3400 (19.0)	4208 (21.1)	<0.001
BMI, kg/m^2	26.8 ± 3.6	25.0 ± 3.8	25.2 ± 3.8	<0.001
WC, cm	90.3 ± 10.2	83.0 ± 10.9	83.7 ± 11.1	<0.001
HbA1c, %	7.9 ± 1.9	5.7 ± 0.5	6.0 ± 1.0	<0.001
FBG, mmol/L	8.8 ± 3.0	5.1 ± 0.6	5.5 ± 1.6	<0.001
SBP, mmHg	141.2 ± 19.6	128.5 ± 18.4	129.8 ± 19.0	<0.001
DBP, mmHg	86.3 ± 11.8	81.6 ± 11	82.1 ± 11.2	<0.001
TC, mg/dL	200.6 ± 45.2	184.4 ± 37.2	186.0 ± 38.4	<0.001
HDL-C, mg/dl	42.2 ± 10.3	45.1 ± 10.7	44.8 ± 10.7	<0.001
LDL-C, mg/dl	111.0 ± 33.5	101.4 ± 29.4	102.4 ± 30.0	<0.001
TG, mg/dl	154.1 ± 1.9	105.8 ± 1.8	110.0 ± 1.9	<0.001

BMI: body mass index; WC: waist circumference; Mets: metabolic equivalents; HbA1c: hemoglobin A1c; FBG: fasting blood glucose; SBP: systolic blood pressure; DBP: diastolic blood pressure; TC: total cholesterol; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; TG: triglycerides.

[a] Values are expressed as means ± SD for continuous variables or n (%) for categorical variables.

[b] Diabetes was defined as fasting blood glucose ≥7.0 mmol/L and/or history of diagnosed diabetes and/or using anti-diabetic agents.

[c] P was for diabetes and non-diabetes.

[d] Physical activity is described as median (interquartile range).

[e] P values were calculated using chi-square test.

[f] P value was calculated using non-parametric test.

Table 2
Characteristics of diabetic participants and excluded participants.[a]

Variables	Diabetic patients	Excluded participants[b]	*P*
n	2061	303	
Age, years	54.1 ± 11.3	41.7 ± 12.5	<0.001
Women	910 (44.2)	151 (49.8)	0.063
Rural	658 (31.9)	201 (66.3)	<0.001
Employed	1178 (57.2)	256 (84.5)	<0.001
Education, years			
<6	286 (13.9)	25 (8.3)	<0.001[d]
7−12	1341 (65.1)	129 (42.7)	
≥13	432 (21.0)	148 (49.0)	
Income, 10,000 yuan/ year			
≤1.9	621 (31.9)	60 (21.8)	<0.001[d]
2.0−3.4	829 (42.5)	116 (42.2)	
≥3.5	499 (25.6)	99 (36.0)	
Physical activity, Mets-hour/week[c]	55.7 (28.0−98.0)	53.4 (24.0−100.0)	0.518[e]
Family history of diabetes	808 (39.2)	45 (14.9)	<0.001
Smoke	849 (41.2)	101 (33.3)	0.009
Alcohol drinking	778 (37.8)	121 (39.9)	0.464
BMI, kg/m^2	26.8 ± 3.6	25.1 ± 4.0	<0.001
WC, cm	90.3 ± 10.2	81.5 ± 12.3	<0.001
HbA1c, %	7.9 ± 1.9	5.9 ± 0.68	<0.001
FBG, mmol/L	8.8 ± 3.0	−	
SBP, mmHg	141.2 ± 19.6	128.3 ± 18.5	<0.001
DBP, mmHg	86.3 ± 11.8	82.9 ± 11.6	<0.001
TC, mg/dl	200.6 ± 45.2	198.5 ± 29.6	0.917
HDL-C, mg/dl	42.2 ± 10.3	40.5 ± 26.9	0.721
LDL-C, mg/dl	111.0 ± 33.5	61.1 ± 51.7	<0.001
TG, mg/dl	154.1 ± 1.9	101.8 ± 1.4	0.157

BMI: body mass index; WC: waist circumference; Mets: metabolic equivalents; HbA1c: hemoglobin A1c; FBG: fasting blood glucose; SBP: systolic blood pressure; DBP: diastolic blood pressure; TC: total cholesterol; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; TG: triglycerides.

[a] Values are expressed as means ± SD for continuous variables or *n* (%) for categorical variables.

[b] Excluded patients mean patients whose diabetic status can't be identified.

[c] Physical activity is described as median (interquartile range).

[d] *P* values were calculated using chi-square test.

[e] *P* value was calculated using non-parametric test.

Discussion

The overall awareness, treatment and control rate of diabetes among Beijing residents in 2011 was 60.9%, 51.3% and 22.4%, respectively. Diabetic patients who were male, younger, lower educated tended to have low awareness, treatment and control rates. Control rate among treated patients was 33.8%, and treated patients who were living in rural, smokers and had dyslipidemia were more difficult to achieve the target of FBG <7.0 mmol/L. Only 22.2% had their FBG- and HbA1c-controlled meanwhile. These data might raise concern of diabetes-related mortality and disease burden in upcoming years.

Diabetes has become a major public health problem in Beijing and China. Many clinical trials and epidemiologic studies showed that glycemic control is fundamental to diabetes management.[12,30,31] Compared with nationwide data, Beijing had higher awareness and treatment rates,[7,17,32,33] while lower contemporaneous control rate. Control rate among all diabetic patients was 22.4% in Beijing and 30.6% nationwide on the basis of FBG < 7.0 mmol/L, and the corresponding data among treated diabetic patients were 33.8% in Beijing and 34.7% nationwide on the basis of FBG < 7.0 mmol/L.[32,33] One plausible explanation is the aging in Beijing, which accounted for ever-increasing numbers of people with diabetes.[34] In addition, elderly diabetic patients were more likely to suffer longer duration, develop concomitant diseases (hypertension, dyslipidemia, abdominal obesity etc.) and progressive impairment of insulin secretion, all of which may result in lower control rate in Beijing.[35−38] Compared with historical data in Beijing in 2005, we

Table 3
Characteristics of HbA1c status among those treated diabetic patients with FBG <7.0 mmol/L.[a]

Variables	FBG < 7.0 mmol/L and HbA1c < 7.0%	FBG < 7.0 mmol/L and HbA1c ≥ 7.0%	*P*
n	247	120	
Age, years	58.0 ± 10.6	58.5 ± 9.9	0.649
Women	147 (59.5)	73 (60.8)	0.809
Rural	59 (23.9)	41 (34.2)	0.038
Employed	99 (40.1)	48 (40.0)	0.988
Education, years			
<6	38 (15.4)	18 (15.0)	0.031[c]
7–12	150 (60.7)	87 (72.5)	
≥13	59 (23.9)	15 (12.5)	
Income, 10,000 yuan/ year			
≤1.9	62 (27.1)	38 (33.3)	0.475[c]
2.0–3.4	110 (48.0)	49 (43.0)	
≥3.5	57 (24.9)	27 (23.7)	
Physical activity, Mets-hour/week[b]	55.5 (28.8–93.6)	63.1 (36.6.0–117.4)	0.057[d]
Family history of diabetes	111 (44.9)	45 (37.5)	0.176
Smoke	68 (27.5)	35 (29.2)	0.744
Alcohol drinking	59 (23.9)	29 (24.2)	0.953
BMI, kg/m^2	25.8 ± 3.8	26.7 ± 3.8	0.027
WC, cm	86.9 ± 10.2	89.2 ± 9.0	0.041
HbA1c, %	6.19 ± 0.48	7.66 ± 0.84	<0.001
FBG, mmol/L	5.81 ± 0.7	6.31 ± 0.6	<0.001
SBP, mmHg	137.5 ± 18.6	144.4 ± 18.4	0.001
DBP, mmHg	81.8 ± 11.1	83.9 ± 11.6	0.094
TC, mg/dl	180.9 ± 39.7	191.3 ± 41.0	0.021
HDL-C, mg/dl	43.2 ± 10.7	43.2 ± 10.2	0.988
LDL-C, mg/dl	99.7 ± 30.7	105.8 ± 31.1	0.075
TG, mg/dl	115.4 ± 1.7	133.4 ± 1.7	0.016

BMI: body mass index; WC: waist circumference; Mets: metabolic equivalents; HbA1c: hemoglobin A1c; FBG: fasting blood glucose; SBP: systolic blood pressure; DBP: diastolic blood pressure; TC: total cholesterol; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; TG: triglycerides.

[a] Values are expressed as means ± SD for continuous variables or *n* (%) for categorical variables.

[b] Physical activity is described as median (interquartile range).

[c] *P* values were calculated using chi-square test.

[d] *P* value was calculated using non-parametric test.

observed a slightly increasing of awareness, treatment and control rates of diabetes. From 2005 to 2011, awareness rate increased from 56.7% to 60.9%, and treatment rate increased from 50.0% to 51.3%, respectively.[19] In 2005, one sixth (15.0%) of all diabetic patients controlled their FBG well. Although the control rate among all patients was still very low, it was nearly one quarter (22.4%) among all diabetic patients in 2011.[19] It might result from economic development, urbanization, policy support, improvement of public health system and basic medical care. However, when compared with developed countries, though Beijing was a metropolitan city, the awareness, treatment and control rates were still much lower.[39–41]

In our study, among all diabetic patients the elderly tended to have higher awareness, treatment and control rates, which may be attributable to more access to physical examination and being more conscious of health. Besides, rapid growth in economy and modernization leads to heavier work stress among men in Beijing, thus men were less aware of their diabetes status and receive treatment.[42] Our study also showed that better educated patients had higher awareness, treatment and control rates, which probably was resulted from higher likelihood of obtaining disease-related knowledge, having better socioeconomic status and being more convenient access to medical care.[41,43] Treated patients living in rural district or having dyslipidemia had poor control situation, which were consistent with previous studies.[7,17,37] For rural patients, the low control rate may be due to their poor medication adherence and lack of disease-related knowledge. In addition, accumulating evidence has demonstrated the comorbidity of dyslipidemia and poor glycemic control in patients with diabetes in China and other countries,[7,37] and association of high free fatty acid with insulin resistance and lipoapoptosis of pancreatic beta-cells.[44] This might be the possible

Table 4
Estimated awareness, treatment and control rates of diabetes in Beijing.

Variables	*n*	Awareness rate[a]		Treatment rate[a]		Control rate among all patients[a]		Control rate among treated patients[a]	
		% (*SE*)[b]	*P*	% (*SE*)[b]	*P*	% (*SE*)[b]	*P*	% (*SE*)[b]	*P*
Total	2061	60.9 (1.3)		51.3 (1.3)		22.4 (1.0)		33.8 (1.7)	
Sex									
Men	1151	54.7 (1.7)	<0.001	44.3 (1.7)	<0.001	18.6 (1.3)	<0.001	30.7 (2.4)	0.061
Women	910	69.5 (1.8)		61.0 (2.0)		27.6 (1.7)		36.8 (2.5)	
Age, years[c]									
18−44	378	39.0 (2.9)	<0.001	26.3 (2.6)	<0.001	13.0 (2.0)	<0.001	25.5 (4.8)	0.162
45−59	1131	60.6 (1.6)		50.5 (1.6)		22.9 (1.4)		35.3 (2.2)	
60−79	552	75.0 (2.3)		68.3 (2.4)		27.5 (2.1)		34.1 (2.9)	
District									
Urban	1403	60.3 (1.5)	0.638	50.7 (1.5)	0.611	24.4 (1.3)	0.028	37.7 (2.0)	0.011
Rural	658	61.7 (2.3)		52.2 (2.4)		19.2 (1.7)		27.8 (2.8)	
Employed									
No	883	71.7 (1.8)	<0.001	64.5 (1.9)	<0.001	26.7 (1.7)	<0.001	35.3 (2.3)	0.215
Yes	1178	50.7 (1.7)		38.9 (1.6)		18.3 (1.3)		31.4 (2.4)	
Education, years[c]									
≤6	286	63.5 (3.7)	0.471	59.3 (3.8)	0.049	20.9 (2.8)	0.532	31.3 (4.6)	0.908
7−12	1341	59.5 (1.6)		50.0 (1.6)		21.9 (1.2)		34.2 (2.0)	
≥13	432	62.4 (2.9)		48.7 (2.8)		24.7 (2.4)		35.0 (3.7)	
Income, 10,000 yuan/year[c]									
≤1.9	621	58.2 (2.6)	0.190	50.4 (2.6)	0.894	18.3 (1.8)	0.023	29.4 (3.1)	0.198
2.0−3.4	829	61.0 (2.0)		51.9 (2.0)		24.1 (1.6)		36.7 (2.6)	
≥3.5	499	64.7 (2.6)		51.4 (2.6)		24.6 (2.2)		33.8 (3.3)	
Smoke									
No	1211	65.9 (1.6)	<0.001	57.0 (1.7)	<0.001	26.0 (1.4)	<0.001	36.7 (2.2)	0.016
Yes	849	54.0 (2.1)		43.5 (2.0)		17.3 (1.5)		28.5 (2.7)	
Alcohol drinking									
No	1283	66.6 (1.6)	<0.001	58.3 (1.7)	<0.001	25.5 (1.4)	<0.001	35.5 (2.8)	0.094
Yes	778	51.5 (2.1)		39.9 (2.1)		17.2 (1.5)		29.7 (2.9)	
Physical activity, Mets·hour/week[c]									
Low	575	57.7 (2.6)	0.278	50.5 (2.7)	0.789	20.5 (2.0)	0.541	32.2 (3.5)	0.877
Moderate	689	62.1 (2.1)		52.8 (2.2)		22.8 (1.8)		33 (2.8)	
High	690	63.0 (2.2)		51.3 (2.2)		23.7 (1.8)		35.2 (2.8)	
Family history of diabetes									
No	1253	54.4 (1.7)	<0.001	46.7 (1.8)	<0.001	20.3 (1.3)	0.010	34.5 (2.4)	0.883
Yes	808	72.3 (1.9)		59.4 (2)		25.9 (1.8)		32.7 (2.4)	
BMI, kg/m^2[c]									
≤23.9	428	66.2 (2.8)	<0.001	55.2 (2.9)	<0.001	30.6 (2.6)	<0.001	41.5 (3.8)	0.058
24.0−27.9	907	64.4 (2.0)		54.4 (2.0)		23.8 (1.6)		33.5 (2.5)	
≥28.0	694	52.0 (2.2)		43.7 (2.1)		16.1 (1.5)		29.9 (2.9)	
Abdominal obesity									
No	583	63.3 (2.4)	0.170	51.4 (2.5)	0.805	27.8 (2.2)	0.002	39.5 (3.3)	0.053
Yes	1437	59.3 (1.6)		50.7 (1.6)		20.4 (1.2)		32.2 (2.0)	
Hypertension									
No	655	58.7 (2.3)	0.281	47.3 (2.3)	0.043	23.1 (1.9)	0.768	34.2 (3.0)	0.946
Yes	1388	61.7 (1.6)		53.0 (1.6)		22.2 (1.3)		34.0 (2.1)	
Dyslipidemia									
No	629	65.3 (2.2)	0.022	53.3 (2.3)	0.309	29.8 (2.1)	<0.001	41.9 (3.1)	0.002
Yes	1432	59.0 (1.6)		50.4 (1.6)		19.3 (1.2)		30.2 (2.0)	

SE: standard error; BMI: body mass index; Mets: metabolic equivalents; FBG: fasting blood glucose.

[a] Awareness was defined as participants' self-reporting a history of physician-diagnosed diabetes among all patients with diabetes. Treatment was defined as use of a prescription medication among all patients with diabetes. Control of diabetes was defined as an FBG level of less than 7.0 mmol/L among patients with diabetes who were treated.

[b] Data are weighted proportions.

[c] *P* was statistic value for trend.

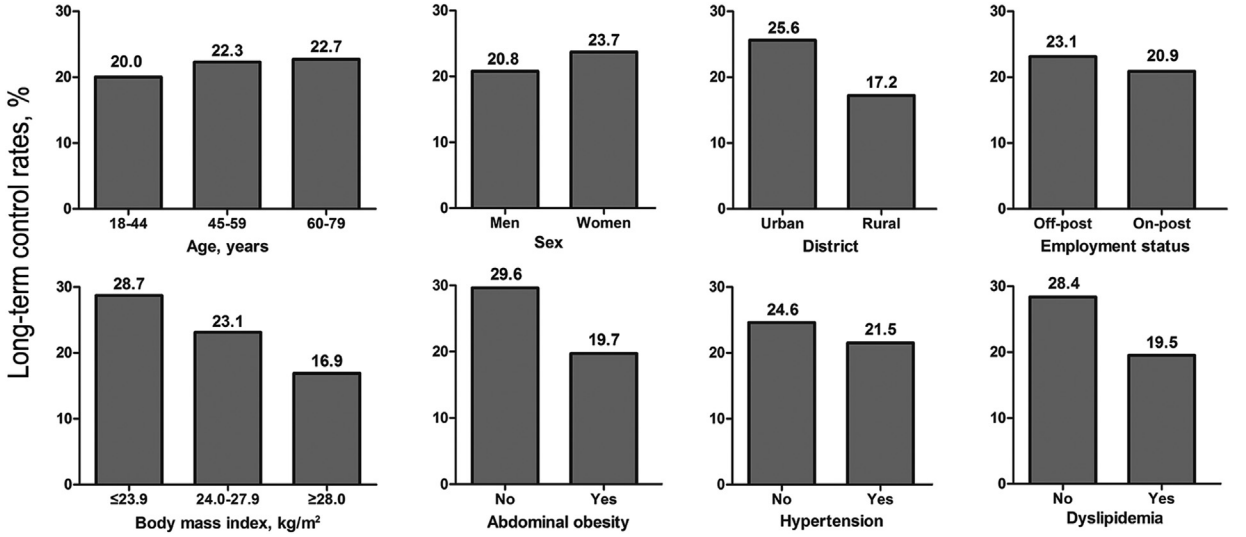

Fig. 2. Proportions of patients whose FBG was <7.0 mmol/L and HbA1c was <7.0% among treated diabetic patients. Proportions were weighted according to the 2010 Beijing Population Census data and the sampling scheme. Differences between/among subgroup populations by district, body mass index, waist circumference and dyslipidemia status were statistically significant ($P < 0.05$). FBG: fasting blood glucose; HbA1c: hemoglobin A1c.

explanation for lower control rate among treated patients with dyslipidemia.

Compared with FBG, HbA1c is a more stable and less day-to-day perturbations index. It could reflect average glucose level over several months veritably. It is demonstrated that intensive therapy among diabetic patients lowered HbA1c levels, further leading to a significant decreased risk of first major cardiovascular event than standard therapy.[31] Studies also showed HbA1c reduction was associated with obvious reduction in microvascular and neuropathic complications.[11,12] Every percentage point drop in HbA1c was estimated to associate with about 40% reduced risk of microvascular complications.[45] Therefore, ADA and CDS recommended HbA1c as an index of long-term glycemic control for treated diabetic patients.[24,25] However, as an indirect index, HbA1c does not reflect true glucose levels, especially in individuals with anemia and hemoglobinopathies.[24] Considering the high prevalence of anemia and hemoglobinopathies in Chinese population,[46] it should be cautious when using HbA1c.

The present study estimated the average HbA1c among patients was 7.9% in Beijing, indicating considerable health benefits if it is controlled adequately. Besides, 120 patients (32.1% of treated diabetic patients) who were considered as well glycemic controlled (FBG < 7.0 mmol/L) still had uncontrolled HbA1c levels (HbA1c $\geq$ 7.0%), indicating they suffered poor long-term glycemic control. These patients tended to have increased risk of cardiovascular event or microvascular complications since poor HbA1c-control was substantially associated with unexpected prognosis of diabetes.[13,14,16,31] In the current study, patients with only FBG-controlled tended to have higher BMI, WC, TC, TG and SBP levels compared with patients whose FBG and HbA1c were both well controlled. Although ADA has suggested patients with HbA1c $\geq$6.5% should be diagnosed as diabetes in American standards of medical care, evidence on cutoff value of HbA1c for diagnosis of diabetes is still insufficient for Chinese population.[47] Therefore, we did not identify diabetic patients integrating HbA1c levels in the present study.

The present study provided reliable estimates of diabetes awareness, treatment and control rates in a most recent cross-sectional survey that was conducted among a large representative sample of general population of Beijing residents. Data collection and samples processing were under strict quality control. However, some limitations should be addressed. First, 2-hour oral glucose tolerance test was not conducted, which may introduce misclassification bias. Second, diabetic status cannot be determined among 303 participants. Compared with diabetic patients, these 303 participants tended to be younger, and lower BMI, WC, blood

Table 5
Multivariate-adjusted odds ratio for risk factors associated diabetic awareness, treatment and control rates.[a]

Variables	Awareness rate		Treatment rate		Control rate among all patients		Control rate among treated patients	
	OR (95%*CI*)	*P*	*OR* (95%*CI*)	*P*	*OR* (95%*CI*)	*P*	*OR* (95%*CI*)	*P*
Age, per 10-year increment	1.87 (1.64–2.14)	<0.001	1.93 (1.70–2.19)	<0.001	1.29 (1.13–1.47)	<0.001	0.95 (0.79–1.14)	0.599
Women	1.73 (1.22–2.46)	0.002	1.52 (1.10–2.11)	0.012	1.81 (1.28–2.57)	0.001	1.43 (0.92–2.21)	0.112
Rural residency	1.13 (0.87–1.47)	0.347	1.20 (0.94–1.55)	0.144	0.80 (0.60–1.06)	0.119	0.67 (0.47–0.96)	0.030
Education								
Moderate education *vs.* low education	1.96 (1.32–2.91)	0.001	1.71 (1.17–2.51)	0.006	1.72 (1.12–2.66)	0.014	1.45 (0.88–2.41)	0.146
High education *vs.* low education	2.87 (1.69–4.87)	<0.001	2.16 (1.33–3.51)	0.002	2.36 (1.35–4.12)	0.003	1.81 (0.91–3.60)	0.094
Income								
Moderate income *vs.* low income	1.16 (0.87–1.55)	0.308	1.09 (0.83–1.43)	0.540	1.38 (1.00–1.90)	0.052	1.32 (0.89–1.95)	0.170
High income *vs.* low income	1.49 (1.01–2.20)	0.046	1.20 (0.84–1.71)	0.319	1.52 (0.98–2.36)	0.062	1.25 (0.71–2.21)	0.438
Smoke	1.12 (0.82–1.52)	0.479	1.07 (0.79–1.44)	0.678	1.09 (0.77–1.54)	0.615	1.00 (0.64–1.55)	0.985
Alcohol drinking	0.72 (0.54–0.97)	0.030	0.66 (0.49–0.87)	0.004	0.77 (0.55–1.09)	0.137	0.80 (0.51–1.25)	0.331
Physical activity								
Moderate PAL *vs.* low PAL	1.03 (0.76–1.39)	0.874	0.93 (0.69–1.25)	0.623	0.99 (0.71–1.39)	0.956	0.94 (0.62–1.44)	0.786
High PAL *vs.* low PAL	1.06 (0.77–1.45)	0.731	0.83 (0.61–1.12)	0.229	1.00 (0.72–1.39)	0.986	0.97 (0.64–1.47)	0.879
Abdominal obesity	0.78 (0.58–1.04)	0.095	0.90 (0.69–1.18)	0.444	0.72 (0.53–0.97)	0.029	0.80 (0.55–1.16)	0.233
Hypertension	0.77 (0.59–1.01)	0.058	0.80 (0.62–1.04)	0.096	0.97 (0.73–1.29)	0.831	1.27 (0.88–1.84)	0.202
Dyslipidemia	0.97 (0.74–1.27)	0.805	1.17 (0.91–1.51)	0.212	0.67 (0.50–0.88)	0.005	0.63 (0.44–0.91)	0.013
Family history of diabetes	2.56 (2.00–3.27)	<0.001	2.00 (1.59–2.51)	<0.001	1.32 (1.02–1.72)	0.038	0.86 (0.62–1.20)	0.385

OR: odds ratio; PAL: physical activity level. Mets: metabolic equivalents.
Tertile cutoff value was 1954.0 and 4890.0 for Mets·hour/wk, respectively; low education, ≤6 years; moderate education, 7–12 years; high education, ≥13 years; low income, ≤19,000 yuan per year; moderate income, 20,000–34,000 yuan per year; high income, ≥35,000 yuan per year; abdominal obesity, ≥90 cm in men/≥80 cm in women; $OR > 1$, indicated a higher proportions of diabetic awareness, treatment or control rate; $OR < 1$, indicated a lower proportions of diabetic awareness, treatment or control rate.

[a] Data are weighted *OR*s and *P* values.

pressure and blood lipid level, which may result in overestimation of diabetes prevalence and underestimation of awareness and treatment rates. Third, we did not further distinguish between type 1 and type 2 diabetes, though type 2 diabetes is the majority of diabetes.

In summary, although the awareness and treatment rates in Beijing were relatively higher than data nationwide, but compared with developed countries the awareness, treatment and control rates of diabetes in Beijing residents were still lower. A comprehensive and intensive intervention strategy on diabetes management, especially on diabetes control, is warranted.

Conflicts of interest

None.

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