

Screening Cardiovascular Risk Factors of Diabetes Patients in the Primary Diabetes Clinics

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Research

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Abstract

Aim:

To evaluate the atherosclerotic cardiovascular diseases (ASCVD) risk factors in type 2 diabetes (T2DM) patients from the primary diabetes clinics for further comprehensive intervention in China.

Methods:

A cross-sectional study was conducted in 5 primary diabetes chain hospitals in Beijing, Lanzhou, Harbin, Chengdu and Taiyuan in continuous patients with T2DM from March 2016 to December 2019. The data collected at the first visit were analyzed, and proportions of patients reached the targets (glycosylated hemoglobin (HbA_{1c}) < 7%, blood pressure < 130 / 80mmHg, and low-density lipoprotein cholesterol (LDL-C) < 2.6mmol/l) were calculated. The differences among different hospitals, different treatment and numbers of aggregated ASCVD risk factors were compared.

Results:

A total of 20,431 participants, including 11,363 men (55.6%), with an average age of (59.4 ± 10.4) years were enrolled. Nearly 95% diabetes had one or more ASCVD risk factors other than hyperglycemia. The control rates of HbA_{1c}, blood pressure, and LDL-C were 26.5%, 27.9%, and 42.6%, respectively. Only 4.1% patients achieved all 3 targets. Diabetes duration, family history and overweight/obesity were associated with the number of aggregated ASCVD risk factors. And the patients with short duration, no overweight/obesity, not smoking, less ASCVD risk factors and lived in Chengdu were associated with a higher control rates.

Conclusions:

In confront of poor control status, global management of ASCVD risk factors including weight loss and smoking stopping must be emphasized in the primary diabetes care settings.

Highlights:

The prevalence of ASCVD risk factors was high and control rates were low in the primary diabetes care hospitals in China.

Overweight/obesity, smoking and resident area were associated with the aggregated ASCVD risk factors and worse control.

Trial registration:

Current ClinicalTrial.gov protocol ID NCT03707379. Date of Registration: October 16, 2018.

<https://clinicaltrials.gov>

Introduction

Diabetes mellitus become an epidemic disease around world including China in the last 3 decades[1, 2]. In the latest national survey[3], the estimated prevalence of diabetes was 10.9% among adult Chinese. Atherosclerotic cardiovascular diseases (ASCVD) are the main cause of death for diabetes patients[4–6]. Meanwhile, obesity, hypertension, dyslipidemia and other ASCVD risk factors are very common in patients with diabetes. A series of art-of-state studies demonstrate that intensive control of hyperglycemia, hypertension and hypercholesterolemia markedly reduces the events of ASCVD in patients with diabetes[7–10]. Steno-2 study[11] shown that a global ASCVD risk control is most effective approach for complication prevention in type 2 diabetes(T2DM), which is the cornerstone for diabetes management. Ten years ago, the China Cardiometabolic Registries 3B (CCMR-3B) study[12] covered 104 hospitals in 6 geographical regions, including 25,817 diabetes patients.It illustrates that the control rates of blood pressure, blood lipid and blood glucose are 28.4%, 42.9% and 47.8%, respectively. Only one in eighteen patients reached all these 3 targets for blood pressure, low-density lipoprotein cholesterol (LDL-C) and glycosylated hemoglobin (HbA_{1c}). In contrast, the improvement of global control of ASCVD risk factors is witnessed in the developed countries like the United States, which lead to a remarkable reduction of diabetes complication, especially ASCVD[13].

In confront of the huge number of diabetes and other non-communicable chronic diseases (NCD) in China, primary care institutions are encouraged by the government to take major responsibility for NCD care. Until now, data regarding the control status of ASCVD risk factors in the primary care settings is limited. Most of all, we need to develop strategies or models for the management of diabetes in this settings. As we know, chronic diseases care models have been developed and implemented elsewhere[14–19]. Regarding to the diabetes care in

primary care setting, a shared care model was developed in Taiwan, where it was proved effective[20]. This model emphasized a continuous care provided by doctors, diabetes educators and dietitians as a team to improve global control for the ASCVD risk factors. The model was introduced from Taiwan by the Ruijing Diabetes Chain Hospitals, including five diabetes specific primary care hospitals in five cities in the mainland China. As the baseline investigation, this cross-sectional study was to evaluate the ACSVD risk factors among T2DM patients who visit primary diabetes clinics at the first time. In addition, the control status and the associated factors were analyzed.

Materials And Methods

Study population

T2DM patients attending Ruijing diabetes hospitals-a chain primary, private, and disease-specific were enrolled. Five hospitals from Beijing, Lanzhou, Harbin, Chengdu and Taiyuan were included. The data collected continuously from March 2016 to December 2019. Eligibility criteria included a diagnosis of T2DM based on the WHO diagnostic criteria in 1999[21], aged between 18 and 80 years old. Those who had serious heart, liver, lung, kidney and other organ dysfunction, being pregnant patients, or had been diagnosed as type 1 diabetes, special type diabetes or gestational diabetes were excluded. This study was approved by the ethics committee of Tsinghua Changgung Hospital (No. [2016] 004).

Data collection

Patient data were collected at the first visiting in each hospital through face-to-face interview, including demographic data, education level, smoking status, individual medical history (hypertension, dyslipidemia, and cardiovascular disease), and family history of diabetes mellitus, treatments (oral antidiabetic agents, insulin, antihypertensive, lipid lowering and antiplatelet agents) of participants were also collected. The height, body weight and waist circumference (WC) were measured. Blood pressure was measured three times with a 3-minute interval by electronic sphygmomanometer after sitting at least 5 minutes. The mean value of the blood pressures was recorded. Blood samples were collected after an overnight, 10–14 hours fasting, and the laboratory tests were conducted in the local hospital, including liver function, renal function, fasting blood glucose, HbA_{1c}, and lipid profiles. HbA_{1c} was measured by high-performance liquid chromatography using the Automatic Glycohemoglobin Analyzer ADAMS™ A_{1c} HA-8180 (Arkay, Japan) or MQ-2000 PT HbA_{1c} analyzer (Huizhong, Shanghai, China), which had achieved the second level reference method certification of glycosylated hemoglobin of International Clinical Chemistry Committee. Blood lipid, liver and kidney function were measured by automated analysis (Beckman counter AU5800, USA). All the labs had participated local province lab quality control as required by the authority. All data were automatically down-loaded from hospital information system.

Diseases definition

Hypertension was defined as blood pressure $\geq 140 / 90$ mmHg, or taking antihypertensive drugs or self-reported previous diagnosis by health care professionals. Hyperlipidemia was defined as LDL-C ≥ 2.6 mmol/l, taking lipid-lowering drugs or self-reported previous diagnosis by health care professionals. Overweight was defined as Body Mass Index (BMI) ≥ 24 kg / m², and obesity was defined as BMI ≥ 28 kg/m²[22].

The control target was $< 7\%$ for HbA_{1c} (A), $< 130 / 80$ mmHg for blood pressure(B), and < 2.6 mmol/l for LDL-C(C) [23].

Statistical analysis

The general data were described for 5 individual hospitals. And the characters of patients were analyzed according to the aggregated numbers of ASCVD risk factors, namely hypertension, hyperlipidemia, overweight/obesity, and smoking. One-way analysis of variance (ANOVA) and General Linear Model were used to compare the mean value of multiple groups. The Chi-Square test was used to compare the rates of multiple groups. Spearman's rank correlation was used to analyze the relationship between numbers of ASCVD risk factors, WC, BMI and control rates. Logistic regression analysis was used to analyze the associated factors with whether or not reaching all 3 ABC targets. $P < 0.05$ was defined as statistically significant. SPSS 20.0 software was used for statistical analysis.

Results

A total of 20,431 patients were investigated, including 11,363 men (55.6%) and 9,068 women (44.4%), with an average age of (59.4 ± 10.4) years (Table 1). The control rates of HbA_{1c}, blood pressure, LDL-Cs were 26.5%, 27.9%, and 42.6%, respectively. Only 4.1% patients achieved all 3 ABC targets. Among five hospitals, 36.4% of patients in Chengdu achieved the HbA_{1c} target, which was the highest, comparing with the lowest percentage in Lanzhou at 18.3%. Patients in Chengdu also had the highest blood pressure control rate (45.7%), while patients in Harbin had the lowest (18.0%). The highest LDL-C control rate was seen in Lanzhou at 49.2%. In contrast, the lowest control rate was in Beijing (35.3%). The percentage for patients reached all 3 targets in Chengdu was the highest (9.2%), while it was the lowest in Harbin (1.9%) among five hospitals.

It was found that patients with more ASCVD risk factors (hypertension, hyperlipidemia, overweight or obesity and smoking) tended to have an older age, a longer duration of diabetes, a larger waist circumference and a higher BMI (Table 2). In addition, more people had family history of diabetes as the risk factors aggregated. Obviously, they tend to have higher HbA_{1c}, blood pressure and LDL-C levels.

In diabetes without other ASCVD risk factors than hyperglycemia, the control rates of HbA_{1c}, blood pressure, LDL-C, and all ABC factors were 31.0%, 52.4%, 100%, and 17.3%, respectively. The control rates were lower in patients with more ASCVD risk factors aggregated (Fig. 1). The percentage of patients achieved all 3 ABC targets did not change much from year 2016 to year 2019 in general (Fig. 2).

When the control rates stratified by treatment used, 17.6% of patients under insulin therapy reached the control rate of HbA_{1c}, 21.0% of patients taking antihypertensive medicine reached the control rate of BP, 39.0% of patients having lipid lowering medicine had their LDL-C < 2.6 mmol/L, which were much lower than the rate of patients who did not (Table 3). Older age, lower BMI, non-smoking, oral hypoglycemic agents only or life intervention only (compared to insulin therapy), without hypertension or hyperlipidemia history, and hospitals (in other hospitals exempt Harbin) were associated with better control of blood pressure, blood lipid and blood glucose simultaneously (Table 4).

Table 1
General characteristic of participants in different clinics

	Total	Beijing	Lanzhou	Harbin	Chengdu	Taiyuan	P value (overall)
Total, n (%)	20431(100.0%)	3055(15.0%)	3500(17.1%)	7578(37.1%)	3251(15.9%)	3047(14.9%)	
Age (years), mean ± SD	59.4 ± 10.4	57.3 ± 10.8	61.0 ± 9.9	58.8 ± 10.5	61.0 ± 10.0	59.3 ± 10.2	< 0.001
Sex (male, %)	11363(55.6%)	1829(59.9%)	2037(58.2%)	4110(54.2%)	1812(55.7%)	1575(51.7%)	< 0.001
Diabetes duration(years),m ± SD	8.8 ± 6.7	9.5 ± 7.4	9.1 ± 5.8	7.9 ± 6.8	9.4 ± 6.3	9.4 ± 6.6	< 0.001
Education							< 0.001
Below high school(%)	8240(40.3%)	1022(33.5%)	1684(48.1%)	1995(26.3%)	1956(60.2%)	1583(52.0%)	
High school and advance(%)	7803(38.2%)	1277(41.8%)	1587(45.3%)	2644(34.9%)	1138(35.0%)	1157(38.0%)	
Education Info.missing (%)	4388(21.5%)	756(24.7%)	229(6.5%)	2939(38.8%)	157(4.8%)	307(10.1%)	
Current smoking (female, %)	147(1.6%)	42(3.4%)	27(1.8%)	33(1.0%)	31(2.2%)	14(1.0%)	< 0.001
Past smoking (female, %)	24(0.3%)	7(0.6%)	3(0.2%)	7(0.2%)	6(0.4%)	1(0.1%)	
Current smoking (male, %)	2194(19.3%)	552(30.2%)	525(25.8%)	259(6.3%)	562(31.0%)	296(18.8%)	< 0.001
Past smoking (male, %)	365(3.2%)	120(6.6%)	43(2.1%)	41(1.0%)	136(7.5%)	25(1.6%)	
WC (male, cm)	91.0 ± 8.8	92.1 ± 9.1	89.8 ± 8.8	92.8 ± 8.7	87.6 ± 7.1	91.4 ± 9.0	< 0.001
WC (female, cm)	87.3 ± 9.3	87.0 ± 9.1	87.1 ± 9.6	88.5 ± 9.5	85.2 ± 7.6	87.5 ± 9.6	< 0.001
BMI (male, kg/m ²)	25.3 ± 3.2	26.0 ± 3.5	24.3 ± 2.9	25.7 ± 3.3	24.6 ± 2.8	25.2 ± 3.2	< 0.001
BMI (female, kg/m ²)	25.1 ± 3.6	25.5 ± 3.8	24.6 ± 3.3	25.5 ± 3.6	24.5 ± 3.3	25.0 ± 3.6	< 0.001
HbA _{1c} (%)	8.4 ± 2.0	8.1 ± 1.9	9.0 ± 2.3	8.4 ± 1.9	7.9 ± 1.9	8.7 ± 2.1	< 0.001
SBP (mmHg)	132.0 ± 18.7	131.6 ± 17.0	129.3 ± 14.4	135.5 ± 20.1	127.9 ± 14.2	131.4 ± 23.1	< 0.001
DBP (mmHg)	79.0 ± 10.6	80.1 ± 10.2	77.2 ± 8.9	82.2 ± 11.2	74.9 ± 8.5	76.6 ± 10.5	< 0.001
LDL-C (mmol/l)	2.76(2.19–3.36)	2.95(2.33–3.60)	2.61(2.10–3.22)	2.83(2.28–3.40)	2.66(2.02–3.29)	2.66(2.11–3.24)	< 0.001
HbA _{1c} < 7%(%)	5423(26.5%)	1016(33.3%)	639(18.3%)	1920(25.3%)	1182(36.4%)	666(21.9%)	0.003
BP < 130/80 mmHg(%)	5696(27.9%)	785(25.7%)	1052(30.1%)	1367(18.0%)	1486(45.7%)	1006(33.0%)	< 0.001
LDL-C < 2.6 mmol/l(%)	8700(42.6%)	1077(35.3%)	1721(49.2%)	2921(38.5%)	1531(47.1%)	1450(47.6%)	< 0.001
Reached two targets	4357(21.3%)	645(21.1%)	734(21.0%)	1275(16.8%)	991(30.5%)	712(23.4%)	< 0.001
Reached three targets	838(4.1%)	135(4.4%)	131(3.7%)	145(1.9%)	301(9.3%)	126(4.1%)	< 0.001
WC: waist circumference; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; BP: blood pressure; LDL-C: low density lipoprotein cholesterol; HbA _{1c} : haemoglobin A _{1c} ; T2DM: type 2 diabetes mellitus.							
Values are represented in mean ± standard deviation or median (25th, 75th percentile) according to their distribution.							

Table 2
Participants reaching control targets of blood pressure, blood lipid or blood glucose by the number of ASCVD risk factors

	Total	T2DM only	T2DM with 1 risk factor	T2DM with 2 risk factors	T2DM with 3 risk factors	T2DM with 4 risk factors	P value (overall)
Total, n (%)	20431(100.0%)	1127(5.5%)	4388(21.5%)	7564(37.0%)	6726(32.9%)	626(3.1%)	
Age (years), mean ± SD	59.4 ± 10.4	57.9 ± 11.2	58.6 ± 10.6	59.5 ± 10.5	60.3 ± 10.0	57.2 ± 10.0	< 0.001
≤ 50	3451(16.9%)	241(21.4%)	845(19.3%)	1307(17.3%)	924(13.7%)	134(21.4%)	
50, ≤ 65	10760(52.7%)	591(52.4%)	2317(52.8%)	3896(51.5%)	3594(53.4%)	362(57.8%)	
≥ 65	6220(30.4%)	295(26.2%)	1226(27.9%)	2361(31.2%)	2208(32.8%)	130(20.8%)	
Sex (male, %)	11363(55.6%)	618(54.8%)	2275(51.8%)	4099(54.2%)	3782(56.2%)	589(94.1%)	< 0.001
Diabetes duration (years), m ± SD	8.8 ± 6.7	7.9 ± 6.1	8.4 ± 6.4	8.7 ± 6.7	9.2 ± 6.9	9.5 ± 6.8	< 0.001
≤ 5	6052(29.6%)	364(32.3%)	1324(30.2%)	2274(30.1%)	1926(28.6%)	164(26.2%)	
5, ≤ 10	4817(23.6%)	271(24.0%)	1045(23.8%)	1797(23.8%)	1541(22.9%)	163(26.0%)	
≥ 10	7385(36.1%)	341(30.3%)	1470(33.5%)	2686(35.5%)	2625(39.0%)	263(42.0%)	
Information missing (%)	2177(10.7%)	151(13.4%)	549(12.5%)	807(10.7%)	634(9.4%)	36(5.8%)	
Education							0.045
Below high school (%)	8240(40.3%)	448(39.8%)	1828(41.7%)	3066(40.5%)	2640(39.3%)	258(41.2%)	
High school and above (%)	7803(38.2%)	450(39.9%)	1682(38.3%)	2832(37.4%)	2533(37.7%)	306(48.9%)	
Information missing (%)	4388(21.5%)	229(20.3%)	878(20.0%)	1666(22.0%)	1553(23.1%)	62(9.9%)	
Current smoking (female, %)	147(1.6%)	0(0.0%)	8(0.4%)	40(1.2%)	62(2.1%)	37(100.0%)	< 0.001
Past smoking (female, %)	24(0.3%)	3(0.6%)	5(0.2%)	11(0.3%)	5(0.2%)	0(0.0%)	
Current smoking (male, %)	2194(19.3%)	0(0.0%)	143(6.3%)	574(14.0%)	888(23.5%)	589(100.0%)	< 0.001
Past smoking (male, %)	365(3.2%)	16(2.6%)	76(3.3%)	156(3.8%)	117(3.1%)	0(0.0%)	
WC (male, cm)	91.0 ± 8.8	84.3 ± 7.7	87.1 ± 7.8	90.7 ± 8.3	94.2 ± 8.3	95.2 ± 8.3	< 0.001
WC (female, cm)	87.3 ± 9.3	80.2 ± 6.4	83.1 ± 7.6	87.1 ± 8.7	91.8 ± 9.2	93.6 ± 8.0	< 0.001
BMI (male, kg/m ²)	25.3 ± 3.2	21.8 ± 1.7	23.3 ± 2.8	25.1 ± 3.0	26.9 ± 2.8	27.2 ± 2.7	< 0.001
BMI (female, kg/m ²)	25.1 ± 3.6	21.5 ± 1.8	22.9 ± 2.8	25.0 ± 3.3	27.5 ± 3.0	27.9 ± 3.0	< 0.001
Paternal family history of diabetes	1797(8.8%)	72(6.4%)	346(7.9%)	643(8.5%)	655(9.7%)	81(12.9%)	< 0.001
Maternal family history of diabetes	2665(13.0%)	118(10.5%)	549(12.5%)	911(12.0%)	956(14.2%)	131(20.9%)	< 0.001
Family history of siblings with diabetes	3309(16.2%)	123(10.9%)	677(15.4%)	1178(15.6%)	1188(17.7%)	143(22.8%)	< 0.001
Information missing (%)	721(3.5%)	28(2.5%)	171(3.9%)	303(4.0%)	190(2.8%)	29(4.6%)	
HbA _{1c} (%)	8.4 ± 2.0	8.4 ± 2.3	8.5 ± 2.2	8.4 ± 2.0	8.4 ± 1.8	8.5 ± 1.9	0.568

	Total	T2DM only	T2DM with 1 risk factor	T2DM with 2 risk factors	T2DM with 3 risk factors	T2DM with 4 risk factors	P value (overall)
≤ 7.0%	5906(28.9%)	381(33.8%)	1380(31.4%)	2190(29.0%)	1793(26.7%)	162(25.9%)	< 0.001
> 7.%, ≤ 9.0%	7785(38.1%)	377(33.5%)	1526(34.8%)	2895(38.3%)	2735(40.7%)	252(40.3%)	
> 9.0%	6740(33.0%)	369(32.7%)	1482(33.8%)	2479(32.8%)	2198(32.7%)	212(33.9%)	
Fasting blood glucose(mmol/l)	9.8 ± 3.8	9.6 ± 3.9	9.8 ± 3.9	9.8 ± 3.8	9.9 ± 3.7	9.7 ± 3.6	0.214
SBP (mmHg)	132.0 ± 2.0	119.5 ± 2.3	123.5 ± 2.2	131.7 ± 2.0	139.3 ± 1.8	139.0 ± 1.9	< 0.001
≤ 140	15763(77.2%)	1127(100.0%)	4107(93.6%)	5926(78.3%)	4202(62.5%)	401(64.1%)	< 0.001
> 141, ≤ 160	3765(18.4%)	0(0.0%)	220(5.0%)	1331(17.6%)	2029(30.2%)	185(29.6%)	
> 160	903(4.4%)	0(0.0%)	61(1.4%)	307(4.1%)	495(7.4%)	40(6.4%)	
DBP (mmHg)	79.0 ± 3.8	73.2 ± 3.9	74.8 ± 3.9	78.8 ± 3.8	82.5 ± 3.7	84.3 ± 3.6	< 0.001
Total cholesterol(mmol/l)	4.97(4.20–5.78)	4.17(3.70–4.64)	4.74(4.05–5.56)	5.00(4.28–5.80)	5.20(4.47–6.00)	4.97(4.21–5.60)	< 0.001
LDL-C (mmol/l)	2.76(2.19–3.36)	2.11(1.77–2.35)	2.50(2.04–3.14)	2.79(2.22–3.37)	3.01(2.52–3.55)	2.99(2.47–3.57)	< 0.001
≤ 2.60	8784(43.0%)	1127(100.0%)	2467(56.2%)	3150(41.6%)	1861(27.7%)	179(28.6%)	< 0.001
> 2.61, ≤ 3.30	6151(30.1%)	0(0.0%)	1031(23.5%)	2369(31.3%)	2525(37.5%)	226(36.1%)	
> 3.30	5496(26.9%)	0(0.0%)	890(20.3%)	2045(27.0%)	2340(34.8%)	221(35.3%)	
Triglyceride (mmol/l)	1.66(1.19–2.40)	1.20(0.90–1.70)	1.45(1.05–2.10)	1.66(1.20–2.40)	1.86(1.34–2.65)	1.99(1.37–2.77)	< 0.001
<p>WC: waist circumference; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; LDL-C: low density lipoprotein cholesterol; HDL-C: high density lipoprotein cholesterol; HbA_{1c}: haemoglobin A_{1c}; T2DM: type 2 diabetes mellitus.</p> <p>Values are represented in mean ± standard deviation or median (25th, 75th percentile) according to their distribution.</p> <p>Risk factors: hypertension, hyperlipidemia, overweight or obesity, smoking.</p>							

Table 3
The control rate stratified by treatment used

	non-insulin used	Insulin used	non-antihypertensive therapy	Antihypertensive therapy	non-lipid lowering therapy	Lipid lowering therapy	Total
BMI < 24 kg/m ²	4340(36.9%)	3282(38.1%)	6004(39.4%)	1618(31.6%)	5858(38.3%)	1764(34.7%)	7622(37.4%)
BMI ≥ 24 kg/m ² , <28	5240(44.6%)	3869(44.9%)	6758(44.4%)	2351(45.9%)	6816(44.6%)	2293(45.2%)	9109(44.7%)
BMI ≥ 28 kg/m ²	2170(18.5%)	1459(16.9%)	2475(16.2%)	1154(22.5%)	2609(17.1%)	1020(20.1%)	3629(17.8%)
HbA _{1c} < 7%	3901(33.1%)	1522(17.6%)	3962(25.9%)	1461(28.4%)	4084(26.6%)	1339(26.3%)	5423(26.5%)
BP < 130/80 mmHg	3363(28.5%)	2333(27.0%)	4619(30.2%)	1077(21.0%)	4352(28.4%)	1344(26.4%)	5696(27.9%)
LDL-C < 2.6 mmol/L	5014(42.5%)	3686(42.6%)	6354(41.5%)	2346(45.7%)	6712(43.8%)	1988(39.0%)	8700(42.6%)
Reached three targets	629(5.3%)	209(2.4%)	661(4.3%)	177(3.4%)	657(4.3%)	181(3.6%)	838(4.1%)

BMI: body mass index; BP: blood pressure; LDL-C: low density lipoprotein cholesterol; HDL-C: high density lipoprotein cholesterol; HbA_{1c}: haemoglobin A_{1c}. *P value compared with non-insulin/ antihypertensive/ lipid lowering therapy: <0.05; **P value compared with non-insulin/ non-antihypertensive/ non-lipid lowering therapy: <0.01.

Table 4
Associated factors of patients reaching all 3 ABC targets

Potential predictor	P value	OR(95% CI)
Age(every 10 years)	0.030	1.10(1.01–1.19)
Gender(male compared to female)	0.737	1.03(0.87–1.22)
Diabetes duration(every 2 years)	0.375	1.05(0.95–1.16)
Education(high school or above compared to below high school)	0.124	1.14(0.97–1.34)
BMI(24 kg/m ² or above compared to below 24 kg/m ²)	< 0.001	0.75(0.64–0.88)
Current smoking (compared to non-smoking and withdraw)	0.004	0.69(0.53–0.88)
Clinic(Beijing compared to Harbin)	< 0.001	2.64(1.94–3.61)
Clinic(Lanzhou compared to Harbin)	< 0.001	1.82(1.36–2.45)
Clinic(Chengdu compared to Harbin)	< 0.001	5.66(4.36–7.34)
Clinic(Taiyuan compared to Harbin)	< 0.001	2.51(1.86–3.40)
Insulin therapy (compared to oral medicine only and life intervention only)	< 0.001	0.40(0.33–0.49)
History of hypertension	< 0.001	0.61(0.51–0.73)
History of hyperlipidemia	< 0.001	0.72(0.60–0.85)

Discussion

This is a large scale cross-sectional study on diabetes patients firstly attending the primary diabetes clinics in 5 big cities in China over 3 years. It provided an overview of the prevalence and the control status of ASCVD risk factors in these diabetes specific primary settings.

Nearly 95% diabetes patients had one or more ASCVD risk factors (hypertension, dyslipidemia, overweight or obesity, and smoking) other than hyperglycemia, and around 73% of them had two or more. These were similar to the results reported in literatures. Lechauncy D et

al[24]. found that 92.2% diabetes patients had one or more comorbidities (hypertension, ischemic heart disease, hyperlipidemia). REACTION study [25] found that 88.8% diabetes patients had at least one additional condition (hypertension, hyperlipidemia, hypothyroidism, hyperthyroidism, or renal insufficiency) was, 53.2% of patients had two or more comorbidities. Harry HX Wang et al. [26] reported that one or more chronic conditions (a total of 52 other chronic diseases including hypertension, hyperlipidemia and coronary heart disease) experienced by 71% diabetes patients in communities.

In consistence with the REACTION research[25], our study showed that the number of ASCVD risk factors increased with the older age, longer diabetic duration, larger waist circumference and higher BMI. In contrary, the control rate of blood glucose was lower as the number of risk factors increased. In addition, the risk factors numbers increased in patients with diabetic family history, which was consistent with the literatures[27–30].

In this study, the control of blood pressure, blood lipid and blood glucose of diabetes patients was poor. Only 26.5% patients attained HbA_{1c} target. It was similar to that (25.9%) in Shaanxi Province in western China[31]. However, it was much lower than the national-wide data (36.7% [25]-47.8% [2, 12, 32]). The reason accounting for the discrepancy might be those data either from a tertiary / secondary hospital[12] or from epidemiological study[32], which might under-estimate a real-world worse situation. Because the former one may represent patients with better medical resources[12], and the later one included a lot of new-diagnosed diabetes patients who had relatively low HbA_{1c}[32]. The achievement of HbA_{1c} control was much lower than that from Americans (55.5%) reported from 2009–2010 NHANES survey [33] and from Spain in 2009 (56.1%)[34]. In addition, 27.9% and 42.6% of diabetes patients achieved blood pressure < 130/80 mmHg and LDL-C < 2.6 mmol/l in our study, respectively. These were nearly the same as those in CCMR-3B study (28.4% and 42.9%) [12] and in Spain (31.7% and 37.9%)[34]. They were also much lower than those in the United States (52.8% and 54.4%)[33]. Regarding the global control rate of HbA_{1c}, blood pressure, and LDL-C, only 4.1% of patients reached all 3 ABC targets in our study, as low as that in Shaanxi Province (4.5%) [31]. And it was even lower than that in CCMR-3B study (5.6%) [12] conducted 10 years ago. The proportion of patients reached all 3 targets was only about one third of the proportion in Spain (12.1%)[34], or was one sixth of the proportion (24.9%) in the United States [33] and Canada (21%)[35]. The unsatisfactory control status may also be due to the selection bias, that is, patients with poor controlled blood glucose might prefer to visit the specialized diabetes clinics instead of general hospital. It was interesting to find the difference among these 5 hospitals. Particularly, patients in Chengdu had the best control of HbA_{1c}, blood pressure and all 3 ABC targets. Better health insurance policy may contribute the achievement in Chengdu. The patients diagnosed with diabetes were granted a special quota for diabetes care by local municipal insurance agency.

We found that patients with older age, shorter duration of diabetes, lower BMI, non-smoking, and oral hypoglycemic agent, had a higher proportion to achieve all 3 therapeutic goals. These were consistent with the findings from other studies[12, 31]. Thus, lifestyle intervention such as stopping smoking and losing weight played an important role in the control of ASCVD risk factors. Cholesterol lowering medicine prescription should increase possibility attained all 3 targets but not found in this study. In other literatures, non-Hispanic Whites rather than Black/African Americans, and Filipino and Hispanics/Latinos[36], men rather than women [37] were more likely to achieve all three goals. This could be due to the low dose of statin used in this country. Patients lived in different area manifested a big difference of achievement ABC target. Here Chengdu was the best, which may due to better health insurance policy in Chengdu. Furthermore, we found that patients under insulin therapy had a lower HbA_{1c} control rate at 17.6%. Patients under antihypertensive and lipid lowering therapy also had a lower control rate. These data suggested that the more ASCVDRFs patients had the harder for achievement of the three targets.

This study has been the first large-scale study from the primary care setting ever in China. The limitation was obvious. Because patients were those visiting hospitals, especially primary diabetes clinics, representing those who need to be treated, the worse situation may be exaggerated. Patients with severe complications and those have well controlled risk factors may not be proportionally recruited in our study. So the participants may not represent the whole T2DM population. In addition, this study lacked individual information of the medical insurance status and economic situation which would also affect the control rate of ASCVD risk factors.

Conclusion

ASCVD risk factors were common and not well controlled in patients with type 2 diabetes. Longer duration smoking, and overweight/obesity were associated with more ASCVD risk factors aggregated. The more commodities aggregated associated with a worse control. Different medical insurance policy may contribute to the control achievement. In order to prevent ASCVD, global management of risk factors, education focus on smoke quitting and weight loss should be emphasized. An affordable insurance policy was also critical.

Declarations

• Ethics approval and consent to participate

This study was approved by the ethics committee of Tsinghua Changgung Hospital (No. [2016] 004).

• Consent for publication

Not applicable

• Availability of data and materials

The datasets generated and analysed during the current study are not publicly available but are available from the corresponding author on reasonable request.

• Competing interests

The authors declare that they have no competing interests

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• Authors' contributions

Yanlei Wang analyzed and interpreted the patient data. Others helped to collect the data from different hospitals. All authors read and approved the final manuscript.

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Figures

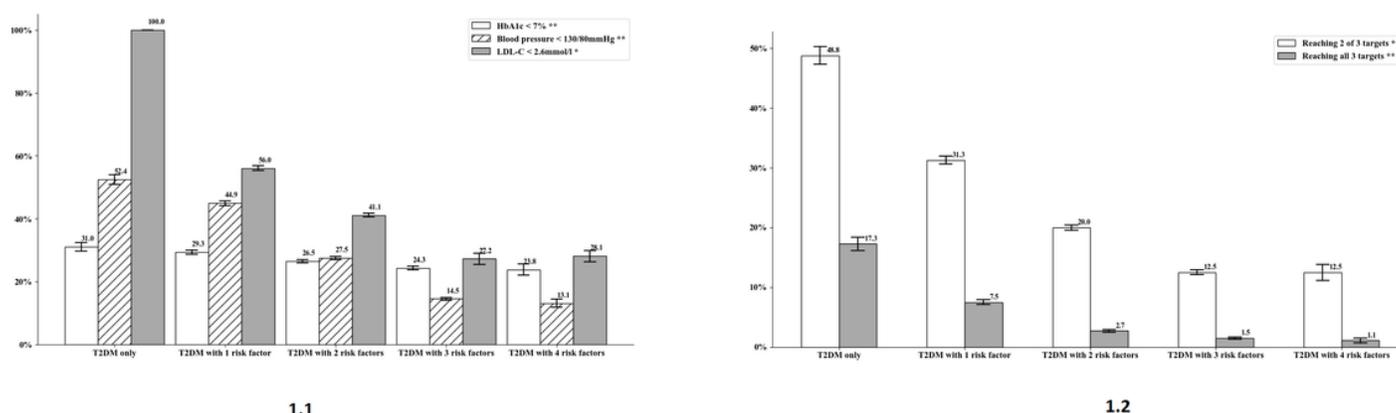
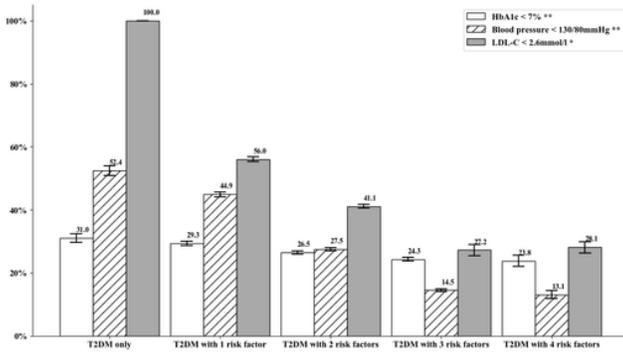
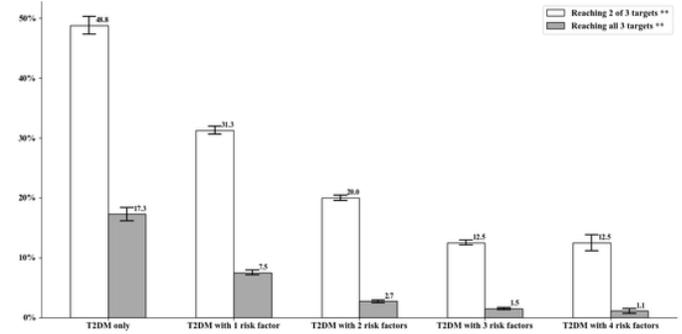


Figure 1

1.1 The percentages of patients reaching control targets of blood pressure, blood lipid or blood glucose by the number of ASCVD risk factors *P value for trend: < 0.05. ** P value for trend: < 0.001. Risk factors: hypertension, hyperlipidemia, overweight or obesity, and smoking. 1.2 The percentages of patients reaching two or three control targets of blood pressure, blood lipid and blood glucose by the number of ASCVD risk factors. ** P value for trend: < 0.001. Risk factors: hypertension, hyperlipidemia, overweight or obesity, and smoking.



1.1



1.2

Figure 1

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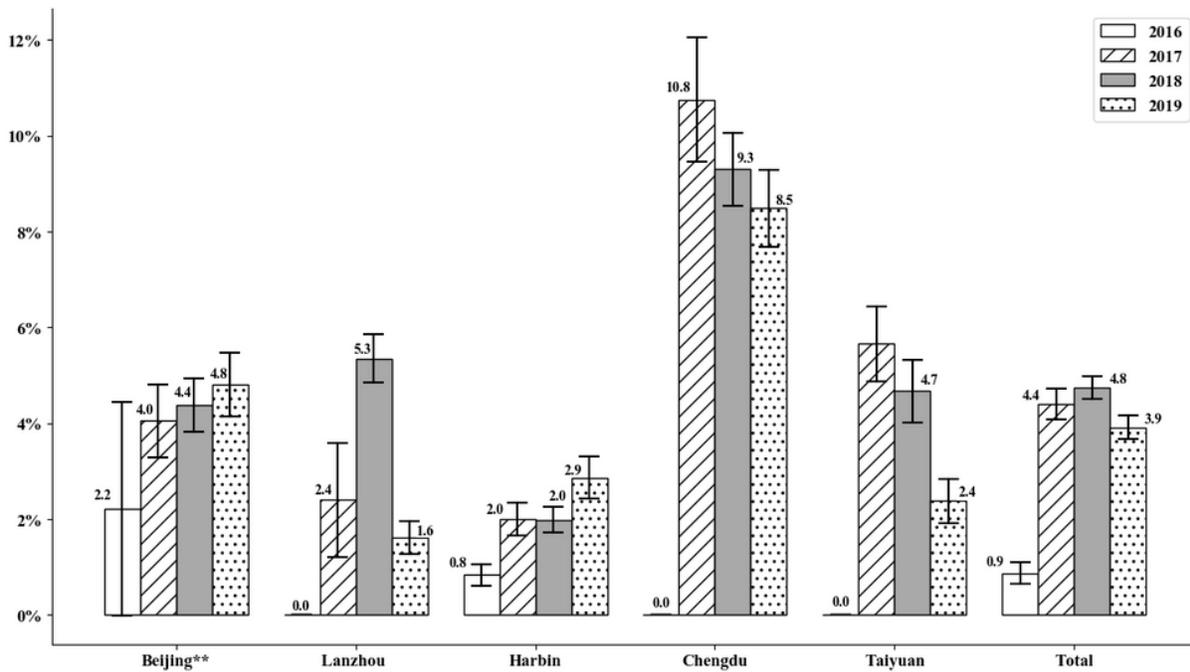


Figure 2

The percentages of patients reaching three control targets of blood pressure, blood lipid and blood glucose by different clinics in different enrollment years ** P value for trend: < 0.001.

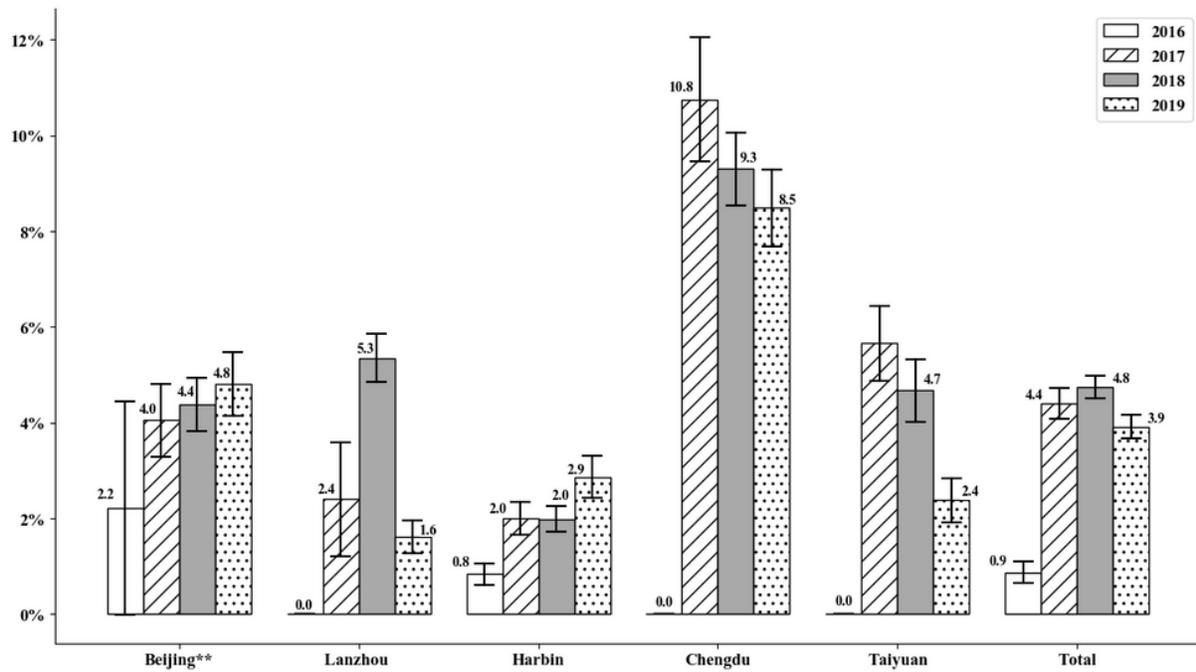


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