MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2015; 21: 1440-1446
DOI: 10.12659/MSM.892246

Received: 2014.08.14
Accepted: 2014.10.22
Published: 2015.05.19

# Glycemic Control Rate of T2DM Outpatients in China: A Multi-Center Survey

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEF 1 Rong Chen
B 2 Linong Ji
B 3 Liming Chen
B 4 Li Chen
B 5 Dehong Cai
B 6 Bo Feng
B 7 Hongyu Kuang
B 8 Hong Li
B 9 Yiming Li
B 10 Jing Liu
B 11 Zhongyan Shan
B 12 Zilin Sun
B 13 Haoming Tian
B 14 Zhangrong Xu
B 15 Yancheng Xu
B 16 Yuzhi Yang
B 17 Liyong Yang
B 18 Xuefeng Yu
B 19 Dalong Zhu
AB 1 Dajin Zou

1 Department of Endocrinology, Changhai Hospital of Second Military Medical University of Chinese PLA, Shanghai, P.R. China
2 Department of Endocrinology, Peking University People's Hospital, Beijing, P.R. China
3 Department of Metabolic Disease, Tianjin Medical University, Tianjin, P.R. China
4 Department of Endocrinology, Qilu Hospital of Shandong University, Jinan, Shandong, P.R. China
5 Department of Endocrinology, Zhujiang Hospital of First Military Medical University, Guangzhou, Guangdong, P.R. China
6 Department of Endocrinology, Shanghai East Hospital, Shanghai, P.R. China
7 Department of Endocrinology, Harbin Medical University, Harbin, Heilongjiang, P.R. China
8 Department of Endocrinology, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University, Hangzhou, Zhejiang, P.R. China
9 Department of Endocrinology, Huashan Hospital of Fudan University, Shanghai, P.R. China
10 Department of Endocrinology, Gansu Provincial Hospital, Lanzhou, Gansu, P.R. China
11 Department of Endocrinology, First Affiliated Hospital of China Medical University, Shenyang, Liaoning, P.R. China
12 Department of Endocrinology, Zhongda Hospital Southeast University, Nanjing, Jiangsu, P.R. China
13 Department of Endocrinology, West China Hospital, Sichuan University, Chengdu, Sichuan, P.R. China
14 Department of Endocrinology, 306th Hospital of PLA, Beijing, P.R. China
15 Department of Endocrinology, Zhongnan Hospital of Wuhan University, Wuhan, Hubei, P.R. China
16 Department of Endocrinology, Heilongjiang Provincial Hospital, Harbin, Heilongjiang, P.R. China
17 Department of Endocrinology, First Affiliated Hospital of Fujian Medical University, Fuzhou, Fujian, P.R. China
18 Department of Endocrinology, Tongji Hospital, Wuhan, Hubei, P.R. China
19 Department of Endocrinology, Nanjing Drum Tower Hospital, Affiliated Hospital of Nanjing University Medical School, Nanjing, Jiangsu, P.R. China

**Corresponding Author:** Dajin Zou, e-mail: zoudajinmedsci@163.com
**Source of support:** Departmental sources

**Background:** Type 2 diabetes mellitus (T2DM)-associated mortality and morbidity are strongly dependent on glycemic control. With T2DM prevalence increasing in China, we aimed to assess glycemic control rates in Chinese T2DM outpatients.

**Material/Methods:** A total of 9065 adult T2DM outpatients (5035 men) were assessed in 26 Chinese medical centers between August 2010 and April 2012. Patients were stratified according to BMI (kg/m$^2$): <24, 24–28, and >28. Successful glycemic control was defined as glycated hemoglobin A1c (HbA1c) ≤7% or fasting plasma glucose (FPG) <7.0 mmol/L.

**Results:** Among the participants included in this study, 2939 had BMI <24, 3361 had BMI of 24–28, and 2764 had BMI >28. The glycemic control rate was only 32.6%, and the triple control rate for glycemia, blood pressure, and lipidemia was only 11.2%. Glycemic control rates by BMI group were 33.7% (<24), 33.8% (24–28), and 30.2% (>28) (p=0.005), and corresponding incidences of cardiovascular diseases (CVD) were 12.2%, 15.7%, and 15.9% (p<0.001). Multivariate logistic regression analysis demonstrated that older age (p<0.001), higher BMI (p=0.026), larger waist circumference (p<0.001), less education (p<0.001), and recent diagnosis (p<0.001) were independent risk factors for poor glycemic control.

**Conclusions:** The T2DM glycemic control rate in China is currently low, especially in older obese patients with poor education and recent diagnosis.

**MeSH Keywords:** China • Diabetes Mellitus, Type 2 • Epidemiology • Obesity

**Full-text PDF:** http://www.medscimonit.com/abstract/index/idArt/892246

2470 3 — 33

## Background

Diabetes is a worldwide epidemic, and China is no exception [1,2]. Type 2 diabetes mellitus (T2DM), the most common form, accounts for nearly 90% of all cases [3]. T2DM incidence is increasing not only in adults but also in youths [4], making it the most urgent public health issue in both developed and developing countries. T2DM is caused by insufficient insulin production from beta cells due to insulin resistance [5]. A combination of lifestyle factors, most notably obesity, and genetic factors has been shown to exacerbate T2DM incidence [6,7].

A new term, "diabesity", has been coined to describe the close association between increasing diabetes incidence and obesity [8]. In UK patients diagnosed with T2DM, for example, almost 90% were also obese or overweight [9]. The increasing prevalence of obesity contributes substantially to the ongoing epidemic of type 2 diabetes [10]. According to current statistics, diabesity will become the major cause of chronic diseases worldwide by the year 2020 [11], and thus represents a substantial current and future economic burden in both developed and developing countries [8]. The deleterious health effects of T2DM are largely due to comorbidities and complications such as hypertension, cardiovascular diseases (CVD), nephropathy, neuropathy, retinopathy, obstructive sleep apnea-hypopnea syndrome (OSAHS), and dyslipidemia, which can result in poor quality of life and reduced life expectancy. Therefore, we examined the associations of diabetes complications and comorbidities such as smoking, drinking, and diabetes duration. Diabesity has important diagnostic and therapeutic implications, as it links various pathophysiological mechanisms associated with insulin resistance and hyperinsulinemia [12]. Obesity worsens insulin resistance and thus promotes the development of diabetes [13,14]; therefore, prevention of obesity is critical for reducing the incidence of T2DM.

Management of T2DM involves controlling risk factors such as hyperlipidemia, and maintaining plasma glucose levels within the normal range [6]. Self-control of glycemia by T2DM patients is recommended [15,16], but its success is generally unknown and the efficacy of self-monitoring in particular groups of patients is controversial [16]. Age, degree of education, and duration of diabetes could impact patient self-control and glycemia control practices. However, little is known about the current status of diabesity in China.

Body mass index (BMI), which is commonly used to identify excessive weight and obesity, is strongly associated with diabetes [17]. Other factors, including hyperglycemia, elevated blood HbA1c, fasting plasma glucose (FPG), and triglyceride (TG), are also indicators of T2DM and some are even more closely correlated with diabetes than BMI [18]. However, studies exploring the association of BMI with other indicators of T2DM or factors affecting T2DM management are scarce.

Despite the increasing prevalence of T2DM in China, with over 110 million adult patients to date [19], limited information is available on the status of glycemic control and management of this population. Therefore, this study aimed to assess glycemic control status and risk factors associated with T2DM management in China.

## Material and Methods

### Study design and participants

This multicenter study assessed patients with T2DM in 26 outpatient medical centers in mainland China, including tertiary hospitals and community health service centers, between August 2010 and April 2012. We performed the surveys by face-to-face interviews and all laboratory indicators were measured in the local hospitals. For study purposes, we defined diabetes mellitus as FPG concentration ≥7.0 mmol/L, 2-h plasma glucose ≥11.1 mmol/L during an OGTT, random plasma glucose ≥11.1mmol/L with classic symptoms of hyperglycemia, HbA1c value ≥7.0%, by self-reported history of physician-diagnosed T2DM or history of drug treatment for diabetes (insulin or oral hypoglycemic agents). All participants gave informed written consent. The protocol was approved by the Ethics Committee of all included centers, and the study was conducted in accordance with the Declaration of Helsinki.

Inclusion criteria were confirmed T2DM, age ≥18 years, body mass index (BMI) over 18, and written informed consent. Patients with gestational diabetes mellitus, secondary diabetes (steroid-induced, cystic fibrosis, hemochromatosis, and chronic pancreatitis), or type 1 diabetes were excluded. Stratified sampling survey was applied during grouping according to the Chinese BMI standard (normal BMI: 18–24, overweight: 24–28, and obese: >28) [20].

### Assessments and outcome measures

Individual demographic characteristics, including level of education, duration of T2DM, medications, self-monitoring status, and other parameters were obtained by a standardized interview. Patients were also required to report specific information about T2DM treatments since their diagnosis, including the types of insulin and oral anti-diabetic drugs. Comorbidities and complications of diabetes such as hypertension, coronary heart disease, and diabetic neuropathy were also recorded. The diagnosis of hyperlipidemia and hypertension was carried out according to Chinese guidelines [21,22].

Cigarette smoking was defined as having smoked a lifetime total of at least 100 cigarettes. Information was obtained on the amount and type of alcohol consumed during the previous year, and "alcohol drinking" was defined as the consumption of at least 30 g of alcohol per week for at least 1 year.





Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Fasting blood samples were collected at 7:00–9:00 AM for measurement of FPG, blood lipids (TG, triglyceride; TC, total cholesterol; HDL, high-density lipoprotein; LDL, low-density lipoprotein), and glycosylated hemoglobin HbA1c. Blood samples were obtained 120 min after meals to measure postprandial glycemia (PPG). Plasma glucose was measured immediately and remaining blood samples were frozen at -80°C until assayed for blood lipids. Body height, weight, and waist circumference were measured. Blood pressure was measured with the participant sitting for at least 5 min and at least 30 min after exercise; it was measured 3 times and the average was recorded. The study participants refrained from cigarette smoking and drinking of coffee, tea, and alcohol for at least 3 h before BP measurement. Successful glycemic control was defined as glycated hemoglobin A1c (HbA1c) ≤7% or fasting plasma glucose (FPG) <7.0 mmol/L

### Statistical analyses

Demographic and clinical characteristics of participants are expressed as mean ± standard deviation for continuous variables and percentages for categorical variables. Groups and subgroups were compared using t-tests and chi-square tests, as appropriate. The adjusted correction of glycemic control rate and BMI was analyzed by partial corrections. A univariate analysis was conducted to identify associations between diabetes control status and demographic and clinical variables. We performed a multivariable logistic regression analysis to identify independent risk factor for poor glycemic control rate by adjusting for age, BMI, waist circumference (WC), level of education, duration of diabetes, smoking, drinking, and hypertension. We present 95% confidence intervals (CI). All P values are 2-tailed, and a P<0.05 was considered statistically significant. Statistical analyses were performed using the statistical software package SPSS for Windows, version 17.0 (IBM-SPSS, Chicago, IL).

## Results

### Characteristics of eligible patients

A total of 9644 subjects with T2DM were enrolled in this study, and 9065 (55.5% male) completed the survey, laboratory tests, and physical measurements used for the final analyses. Demographic data and baseline characteristics of participants are shown in Table 1. Among them, 2764 patients had BMI >28 kg/m$^2$, 953 had BMI >30 kg/m$^2$ (34.5%), and 420 had BMI >32 kg/m$^2$ (15.2%).

### Glycemia, lipidemia, and blood pressure control status

Only 656 (7.2%) subjects had never received any oral anti-diabetic drugs (OADs) or insulin, with 221, 243, and 192 subjects in the BMI <24, BMI 24–28, and BMI >28 groups, respectively. In the whole study cohort, 60.32% had never received OADs and 41.03% were insulin naive. The lowest usage rates were in the BMI >28 group – only 36.09% patients used OADs and only 35.05% were on insulin (Table 1).

The glycemia control rates among study subjects are shown in Table 2. According to Chinese criteria, 1809 of 8434 (32.6%) achieved glycemic control and 943 of 8434 (11.2%) achieved triple control of glycemia, blood pressure, and lipidemia. Next, we evaluated the impact of BMI on the glycemic control rate. Glycemic control rates differed among BMI groups, with 33.7% in the <24 group, 33.8% in the 24–28 group, and 30.2% in the >28 group (p=0.005), even after partial corrections analysis adjusting for age, degree of education, duration of diabetes, HbA1c, and FPG (p=0.006). The glycemic control rates also differed significantly across subgroups defined by age, level of education, and duration of diabetes (p=0.015, <0.001, and <0.001, respectively). Glycemic control rates differed significantly in the 3 BMI subgroups of patients ≥75 years old (p=0.022), with high school education (p=0.019), <3 year disease duration (=0.007), and with 3–5 years disease duration (*p*=0.026). Glycemic control rates also differed significantly across age groups (p=0.015), education levels (p<0.001), and disease durations (p<0.001) (Table 2). With increasing BMI, triple control rate decreased significantly – 12.8% was recorded for BMI <24, while 12.1% and 8.5% were obtained for the BMI 24–28 and BMI >28 groups (p<0.001, Table 2).

### Comorbidities and complications

The incidences of CVD differed significantly in the 3 BMI groups, with 12.2% in the <24 group, 15.7% in the 24–28 group, and 15.9% in the >28 group (*p*<0.001). The incidences of CVD also differed significantly across disease duration groups (8.1% at <3 years, 19.7% at 3–5 years, and 15.8% in the >5 years group; p<0.001). Moreover, the incidences of CVD varied significantly by BMI within the 3–5 years disease duration group (*p*<0.001). Overall, 7.2% of T2DM outpatients had nephropathy, regardless to the BMI value (7.1% in the <24 group, 6.6% in the 24–28 group, and 7.9% in the >28 group; *p*=0.153). Overall incidences of retinopathy and neuropathy were 9.2% and 11.5%, similar across BMI groups (*p*=0.256, p=0.199, respectively) (Table 1).

### Risk factors of good glycemia control

Age, BMI, WC, level of education, and duration of diabetes were significant risk factors according to univariate analysis. In agreement with this, multivariate logistic regression demonstrated that age (OR: 1.170, 95%CI: 1.094–1.251, p<0.001), BMI (OR: 1.100, 95%CI: 1.011–1.195, p=0.026), WC (OR: 0.983, 95%CI: 0.977–0.989, p<0.001), education level (OR: 1.380,





Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

**Table 1.** Baseline characteristics of included patients.

| Characteristics | BMI <24 kg/m$^2$ | 24–28 kg/m$^2$ | BMI >28 kg/m$^2$ | P |
|---|---|---|---|---|
| Number of patients | 2939 | 3361 | 2764 | |
| Age(Year) | 58.90±17.95 | 58.83±12.59 | 56.01±13.37$^{\#}$ | <0.001 |
| Age <45 | 13.3% | 12.4% | 19.2% | |
| 45≤ age <60 | 39.2% | 39.0% | 41.2% | |
| 60≤ age <75 | 34.9% | 37.0% | 31.3% | |
| Age ≥75 | 12.6% | 11.6% | 8.6% | |
| Male (%) | 51.3% | 58.3% | 58.2% | <0.001 |
| Duration of diabetes (year) | | | | <0.001 |
| <3 y | 22.3% | 21.7% | 24.0% | |
| 3–5 y | 43.4% | 43.6% | 32.3% | |
| >5 y | 34.3% | 34.8% | 43.7% | |
| Family history | 3.3% | 3.5% | 3.7% | 0.723 |
| Weight (kg) | 60.51±8.63 | 71.61±8.29 | 84.29±11.90 | <0.001 |
| Waist circumference (cm) | 82.51±8.7 | 90.57±8.4 | 99.57±9.8 | <0.001 |
| Hip circumference (cm) | 91.61±8.83 | 97.89±9.18 | 104.87±9.96 | <0.001 |
| Waist to hip ratio | 0.90±0.07 | 0.93±0.07 | 0.95±0.07 | <0.001 |
| Degree of education (%) | | | | <0.001 |
| Illiteracy | 5.4% | 5.4% | 5.4% | |
| Primary school | 16.0% | 12.4% | 12.9% | |
| high school | 60.6% | 60.0% | 59.7% | |
| College and higher | 18.0% | 22.3% | 22.0% | |
| Smoking (%) | 23.7 | 26.1 | 26.9 | 0.006 |
| Drinking (%) | 14.1% | 17.1% | 20.4% | <0.001 |
| FPG (mmol/L) | 11.4±4.7 | 10.9±4.2 | 11.1±4.4 | <0.001 |
| PPG (mmol/L) | 16.03±5.69 | 15.27±5.06 | 15.65±5.21 | <0.001 |
| HbA1c (%) | 9.24±2.41 | 8.88±2.12 | 9.09±2.17 | <0.001 |
| LDL-c (mmol/L) | 2.84±1.02 | 2.93±1.18 | 2.93±1.12 | 0.003 |
| HDL-c (mmol/L) | 1.31±0.75 | 1.20±0.59 | 1.19±0.90 | <0.001 |
| TC (mmol/L) | 4.79±2.66 | 4.84±2.77 | 5.25±13.78 | 0.078 |
| TG (mmol/L) | 2.06±7.67 | 2.49±8.98 | 9.08±2.17 | 0.008 |
| OADs | 45.12% | 37.88% | 36.09% | <0.001 |
| Insulin | 52.43% | 35.97% | 35.05% | <0.001 |
| Retinopathy | 8.6% | 9.3% | 9.9% | 0.256 |
| Neuropathy | 12.3% | 11.0% | 11.1% | 0.199 |
| Nephropathy | 7.1% | 6.6% | 7.9% | 0.153 |
| Cardiovascular diseases | 12.2% | 15.7% | 33.1% | <0.001 |
| Hypertension | 38.5% | 52.8% | 61.2% | <0.001 |
| OSAHS | 0.2% | 0.6% | 2.6% | <0.001 |

FPG – fasting plasma glucose; PPG – postprandial hyperglycemia; TG – triglyceride; TC – total cholesterol; HDL – high density lipoprotein; LDL – low density lipoprotein; OADs – oral anti-diabetic drugs; OSAHS – obstructive sleep apnea-hypopnea syndrome.





Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System]
[ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica]
[Chemical Abstracts/CAS] [Index Copernicus]

**Table 2.** Glycemia control rates of each groups and subgroups in T2DM patients.

| | Total | BMI <24 | 24 ≤BMI <28 | BMI ≥28 | P |
|---|---|---|---|---|---|
| Triple control rates | 11.2% | 12.8% | 12.1% | 8.5% | <0.001 |
| Glycemia control rates | 32.6% | 33.7% | 33.8% | 30.2% | 0.005 |
| Age | | | | | |
| Age <45 y | 29.4% | 32.1% | 29.3% | 27.6% | 0.353 |
| 45≤ age <60 | 32.3% | 32.0% | 33.9% | 30.7% | 0.261 |
| 60≤ age <75 | 34.5% | 34.9% | 35.8% | 32.0% | 0.212 |
| Age ≥75 | 32.9% | 37.8% | 32.2% | 26.6% | 0.022 |
| p | 0.015 | | | | |
| Degree of education | | | | | |
| Illiteracy | 23.4% | 24.6% | 24.5% | 20.9% | 0.709 |
| Primary school | 27.7% | 28.4% | 28.3% | 26.2% | 0.774 |
| High school | 32.7% | 33.8% | 34.2% | 29.9% | 0.019 |
| College and higher | 38.2% | 39.3% | 40.5% | 34.4% | 0.088 |
| p | <0.001 | | | | |
| Duration of diabetes | | | | | |
| <3 y | 39.7% | 41.6% | 42.9% | 34.5% | 0.007 |
| 3–5 y | 31.4% | 31.6% | 33.6% | 27.7% | 0.026 |
| >5 y | 32.3% | 32.6% | 32.4% | 31.8% | 0.939 |
| p | <0.001 | | | | |

**Table 3.** Univariate and multivariate logistic regress analysis for risk factors of glycemia control.

| Variables | Univariate | | Multivariate | |
|---|---|---|---|---|
| | OR (95%CI) | p | OR (95% CI) | *P* |
| Age | 1.017 (1.016–1.029) | 0.011 | 1.170 (1.094–1.251) | <0.001 |
| BMI | 0.923 (0.871–0.978) | 0.006 | 1.100 (1.011–1.195) | 0.026 |
| Waist circumference | 0.988 (0.984–0.992) | <0.001 | 0.983 (0.977–0.989) | <0.001 |
| Degree of education | 1.169 (1.120–1.220) | <0.001 | 1.380 (1.280–1.489) | <0.001 |
| Duration of diabetes | 0.863 (0.811–0.919) | <0.001 | 0.841 (0.785–0.901) | <0.001 |
| Smoking | 1.073 (1.017–1.131) | 0.01 | 1.068 (0.997–1.144) | 0.061 |
| Drinking | 1.079 (0.954–1.219) | 0.225 | 1.016 (0.866–1.191) | 0.846 |
| Hypertension | 1.044 (0.953–1.143) | 0.357 | 1.044 (0.932–1.169) | 0.458 |

95%CI: 1.280–1.489, p<0.001), and recent diagnosis (OR: 0.841, 95%CI: 0.785–0.901, p<0.001) were significant independent risk factors for poor glycemic control (Table 3).

## Discussion

Diabetes is becoming a major public health issue and economic burden in China. Glycemia control is closely associated





Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

with complications and prognosis [23–25], so efficient glycemia control is considered a cornerstone of diabetic treatment. The results of this multi-center investigation revealed an unsatisfactory overall glycemia control rate for T2DM patients; most patients did not meet the management criteria of the American Diabetes Association (ADA) or Chinese glycemia control of HbA1c <7%. Moreover, the glycemia control rate was very low for obese patients, particularly those with BMI >28 kg/m$^2$. Level of education, duration of T2DM, waist circumference, and HbA1c level were found to be major factors affecting glycemic control rate in T2DM patients.

The overall glycemia control rate in our study was 32.6%, lower than the 39.7% obtained in a study assessing individuals with HbA1c <7% [26]. In a more recent study in China, only 31.78% of 238 639 diabetes patients exhibited HbA1c <7% after treatment [27]. The latter study assessed drug use (OADs and/or insulin) but did not include education level or lifestyle data. To explore possible risk factors influencing the management of glycemia, we evaluated age, educational level, BMI, WC, duration of T2DM, smoking, drinking, and hypertension, which are factors strongly linked to T2DM risk in previous studies and easily measured in large cohorts. We found that high level of education, recent diagnosis of T2DM, young age, and low BMI were strongly related to good glycemia control. Here, the cutoff BMI value for obesity was set at ≥28 kg/m$^2$, in accordance with a study reporting the most effective index for T2DM in China [28]. Due to the diversity of Chinese diet and difficulty in quantifying exercise, exercise and diet control were not taken into consideration in this analysis. Multivariate logistic results also demonstrated that age, education, BMI, and duration of T2DM were important risk factors for glycemia control. Therefore, significant efforts should be undertaken to monitor and encourage elderly patients, patients with low-level education, long-term T2DM patients, and high BMI patients to improve glycemic control, which would ameliorate treatment outcome in these individuals and decrease T2DM prevalence. The observation that individuals with high education levels have reduced risk of hyperglycemia may results from their better understanding of diabetes, obesity risks, and glycemic control [29]. These findings stress the importance of education in the epidemiology of T2DM. At this point, it is not clear why higher BMI and elderly individuals were reluctant in applying glycemia control. However, this phenomenon was more pronounced in diabesity patients >75, indicating that poor general fitness might play a role in the reduced glycemia control. Further studies need to address this point. A recent study showed that age and BMI are less important factors that can influence quality of life; a weak positive relation was determined for these factors only with 4 of 10 fields of quality of life, including social functioning, emotional state, physical health, and mental health [30]. A study conducted in the USA indicated that 84.5% of the hospitalized type 2 diabetes patients were overweight or obese (BMI ≥25 kg/m$^2$), suggesting the need for effective weight loss intervention in this population [31].

As smoking and drinking are proven risk factors for several chronic diseases, we evaluated their roles in diabetes complications. In this study, we found no significant effects for smoking and drinking, possibly due to the limited sample size and the larger impacts of other parameters studied, including education level, WC, and duration of T2DM. It is possible that proper patient education could also help patients control drinking and smoking when these habits put them at risk.

High BMI is a known important risk factor for comorbidities and complications of T2DM [32]. In agreement, higher BMI was found to be associated with increased prevalence of CVD and other comorbidities, indicating that weight loss strategies are an important component of both T2DM prevention and treatment. Interestingly, acupuncture therapy was recently shown to be effective in preventing the development of type-2 diabetes mellitus in a rat model [33], suggesting an alternative method that might be widely accepted by the Chinese population. However, it should be noted that acupuncture did not reduce body weight in rats.

There are several limitations in this study. First, we did not use multistage cluster sampling methods. Second, data derived from interviews rather than tests may have been affected by recall errors or bias. Descriptive analyses were applied throughout this study without attempting to control for confounding factors. Nonetheless, we present a comprehensive portrait of current glycemic control rates in Chinese outpatients and identify risk factors affecting control of blood glucose and other aspects of disease management.

## Conclusions

The T2DM glycemic control rate in China is currently poor, especially in older obese patients with poor education and recent diagnosis. Efforts to achieve good glycemic control and reduce risk factors are highly recommended. Educational interventions for glycemic control and weight loss could help patients with low-level education and decrease diabetes prevalence.

### Conflict of interests

All authors declare that they have no any conflict of interests.



Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

## References:

1. Ramachandran A, Ma RC, Snehalatha C: Diabetes in Asia. Lancet, 2010; 375: 408–18
2. Chen CM: Overview of obesity in Mainland China. Obes Rev, 2008; 9(Suppl.1): 14–21
3. American Diabetes Association: Diagnosis and classification of diabetes mellitus. Diabetes Care, 2013; 36(Suppl.1): S67–74
4. Samaan MC: Management of pediatric and adolescent type 2 diabetes. Int J Pediatr, 2013; 2013: 972034
5. Gardner D, Shoback D (eds.): Greenspan's basic & clinical endocrinology. 9th ed. New York: McGraw-Hill Medical, 2011
6. Ripsin CM, Kang H, Urban RJ: Management of blood glucose in type 2 diabetes mellitus. Am Fam Physician 2009; 79: 29-36.
7. Riserus U, Willett WC, Hu FB: Dietary fats and prevention of type 2 diabetes. Prog Lipid Res, 2009; 48: 44–51
8. Farag YM, Gaballa MR: Diabesity: an overview of a rising epidemic. Nephrol Dial Transplant, 2011; 26: 28–35
9. Whitmore C: Type 2 diabetes and obesity in adults. Br J Nurs, 2010; 19: 880, 882–86
10. Scheen AJ, Van Gaal LF: Combating the dual burden: therapeutic targeting of common pathways in obesity and type 2 diabetes. Lancet Diabetes Endocrinol, 2014; 2(11): 911–22
11. Chauhan HK: Diabesity: the 'Achilles Heel' of our modernized society. Rev Assoc Med Bras, 2012; 58: 399
12. Kalra S: Diabesity. J Pak Med Assoc, 2013; 63: 532–34
13. Riobo Servan P: Obesity and diabetes. Nutr Hosp, 2013; 28(Suppl.5): 138–43
14. Ramachandran A, Chamukuttan S, Shetty SA et al: Obesity in Asia – is it different from rest of the world. Diabetes Metab Res Rev, 2012; 28(Suppl.2): 47–51
15. Webster MW: Clinical practice and implications of recent diabetes trials. Curr Opin Cardiol, 2011; 26: 288–93
16. Szymborska-Kajanek A, Psurek A, Hese R, Strojek K: Self-monitoring of blood glucose in treatment of type 2 diabetes. Diabetes Res Clin Pract, 2009; 86(Suppl.1): S49–52
17. Eckel RH, Kahn SE, Ferrannini E et al: Obesity and type 2 diabetes: what can be unified and what needs to be individualized? Diabetes Care, 2011; 34: 1424–30
18. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia. World Health Organization. Geneva, 2006: 21
19. Xu Y, Wang L, He J et al: Prevalence and control of diabetes in Chinese adults. JAMA, 2013; 310: 948–59
20. Zhou B, Coorperative Meta-Analysis Group Of China Obesity Task Force: [Predictive values of body mass index and waist circumference to risk factors of related diseases in Chinese adult population.] Chinese Journal of Epidemiology, 2002; 23: 5–10 [in Chinese]
21. Chinese Guidelines on Prevention and Treatment of Dyslipidemia in Adults: [Joint committee for developing Chinese guidelines on prevention and treatment of dyslipidemia in adults.] Chinese Journal of Cardiology, 2007; 35: 390–419 [in Chinese]
22. Writing Group of 2010 Chinese Guidelines for the Management of Hypertension: [Hypertension Drug therapy Disease management Guidelines.] Chinese Journal of Cardiology, 2011; 39: 579–616 [in Chinese]
23. Oomichi T, Emoto M, Tabata T et al: Impact of glycemic control on survival of diabetic patients on chronic regular hemodialysis: a 7-year observational study. Diabetes Care, 2006; 29: 1496–500
24. Yoo DE, Park JT, Oh HJ et al: Good glycemic control is associated with better survival in diabetic patients on peritoneal dialysis: a prospective observational study. PloS One, 2012; 7: e30072
25. Poolsup N, Suksomboon N, Rattanasookchit S: Meta-analysis of the benefits of self-monitoring of blood glucose on glycemic control in type 2 diabetes patients: an update. Diabetes Technol Ther, 2009; 11: 775–84
26. Zhang SL, Chen ZC, Yan L et al: Determinants for inadequate glycaemic control in Chinese patients with mild-to-moderate type 2 diabetes on oral antidiabetic drugs alone. Chin Med J (Engl), 2011; 124: 2461–68
27. Ji LN, Lu JM, Guo XH et al: Glycemic control among patients in China with type 2 diabetes mellitus receiving oral drugs or injectables. BMC Public Health, 2013; 13: 602
28. Ma RC, Chan JC: Type 2 diabetes in East Asians: similarities and differences with populations in Europe and the United States. Ann NY Acad Sci, 2013; 1281: 64–91
29. World Health Organization. Obesity and overweight. 2013. Available from: *URL:http://www.who.int/mediacentre/factsheets/fs311/en/*
30. Mikailiūkštienė A, Juozulynas A, Narkauskaitė L et al: Quality of life in relation to social and disease factors in patients with type 2 diabetes in Lithuania. Med Sci Monit, 2013; 19: 165–74
31. Blumentals WA, Hwu P, Kobayashi N, Ogura E: Obesity in hospitalized type 2 diabetes patients: a descriptive study. Med Sci Monit, 2013; 19: 359–65
32. Yao L, Herlea-Pana O, Heuser-Baker J et al: Roles of the Chemokine System in Development of Obesity, Insulin Resistance, and Cardiovascular Disease. J Immunol Res, 2015; 2114: 181450
33. Nakamura H, Ishigami T, Kawase Y et al: Effects of acupuncture stimulation on blood glucose concentration in the Otsuka Long-Evans Tokushima Fatty (OLETF) rat, an animal model for type-2 diabetes mellitus. Med Sci Monit Basic Res, 2015; 21: 70–75





Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]