

## Trends and regional differences in glycemic control of patients with type 2 diabetes in China, 2009–2013

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*To the Editor:* According to the International Diabetes Federation, China has been ranked first worldwide in terms of the prevalence of diabetes among people aged 20 to 79 years.<sup>[1]</sup> As a cornerstone in the management of patients with type 2 diabetes mellitus (T2DM), the level of glycemic control has changed considerably over the past decades. A multicenter observational study in North China showed that 45.82% of patients with T2DM met the glycated hemoglobin (HbA1c) control standard in 2017.<sup>[2]</sup> With the largest population of residents with T2DM, China is also faced with significant regional discrepancies in the rates of adequate glycemic control (HbA1c <7%), ranging from 25.9% in Shaanxi province<sup>[3]</sup> to 56.1% in Jiangsu province.<sup>[4]</sup> Indeed, previous studies in China were conducted for short periods of time, in a limited number of areas, and with relatively small sample sizes. Based on the data of the China National HbA1c Surveillance System study (CNHSS), this analysis aimed to investigate temporal trends and regional variations in glycemic control in T2DM patients in China from 2009 to 2013.

The study was approved by the Ethics Committee of Chinese PLA General Hospital (No. 20090118). After obtaining written informed consent, we began the data collection of all patients. In 2009, the Chinese Diabetes Society launched the CNHSS to monitor glycemic control of T2DM outpatients, which continued through 2013. We conducted a retrospective analysis using the data from the CNHSS. The details of the study methods were published elsewhere.<sup>[5]</sup> During the recruitment period, the first seven qualified patients of each hospital everyday were invited to participate in the survey. The recruitment period was 3 months, or it would end when 400 participants were recruited from each study site. Finally, we analyzed the data of 956,352 patients with T2DM. During the recruitment period, the trained professionals collected patients' data using a standardized questionnaire. The questionnaire was used to record data, including demographic characteristics, physical examina-

tions, diabetes diagnosis, diabetes complications, comorbidities, and laboratory tests. Regardless of the treatment for T2DM patients (oral antidiabetic drugs or insulin), adequate glycemic control was defined as HbA1c values of <7%. For glycemic control, we calculated age-standardized rates of different HbA1c categories for each year using the national population census of China in 2010 as the reference. The rates of adequate glycemic control in the seven geographic regions of the pooled data were calculated. To assess the increased risk of inadequate HbA1c control, multivariable logistic regression analysis was used to evaluate odds ratios (ORs) and 95% confidence intervals (95% CIs) of adequate glycemic control between different geographic regions (the region with the highest rates of adequate glycemic control was treated as the reference region). Two-tailed *P* values <0.05 were considered to indicate statistical significance for all analyses. Statistical analysis was performed using the SPSS, version 21.0 (IBM SPSS, Armonk, NY, USA).

As shown in Supplementary Table 1, <http://links.lww.com/CM9/A857>, the mean age was 58.7 (standard deviation, 11.5) years and patients in 2013 were younger than those in 2009. The proportion of males was 53.5% among all participants. Body mass index (BMI) remained stable over this period with a mean of >24.0 kg/m<sup>2</sup>. The median duration of diabetes was 4.7 years in 2009, reducing to 4.1 years in 2013 (interquartile range [IQR]: 1.6–8.1). The mean HbA1c during this period was nearly 8%.

Standardized rates (95% CI) of glycemic control are shown in Supplementary Figure 1 and Supplementary Table 2, <http://links.lww.com/CM9/A857>. From 2009 to 2013, the proportion of patients with HbA1c ≥9% experienced a downward trend from 33.3% (33.0%, 33.5%) to 30.4% (30.2%, 30.6%) (*P* < 0.001). Meanwhile, the proportion of patients with HbA1c 7% to < 9% increased from 38.1% to 47.1% (*P* < 0.001). Of note, the proportion of patients with

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HbA1c < 7% significantly declined from 28.6% to 22.6% ( $P < 0.001$ ).

Glycemic control varied by duration of diabetes [Supplementary Table 3, <http://links.lww.com/CM9/A857>]. To avoid the effect of newly diagnosed diabetes on glycemic control, we excluded patients with duration of diabetes < 1 year. The remaining patients were divided into three groups according to the duration of diabetes (1 to < 5 years [group 1], 5 to < 10 years [group 2], and  $\geq 10$  years [group 3]). In group 1, the proportion of patients with HbA1c values of < 7% and  $\geq 9\%$  decreased considerably over 5 years, whereas the proportion of those with HbA1c values of 7–< 9% underwent an upward trend. A similar trend in glycemic control was seen in patients who had diabetes for 5 to < 10 years (group 2). However, the trend was different among patients in group 3. In particular, the proportion of patients with HbA1c values of < 7% and 7–< 9% increased significantly, whereas that of those with HbA1c values of  $\geq 9\%$  decreased.

Glycemic control also varied by age [Supplementary Table 4, <http://links.lww.com/CM9/A857>]. Based on the age, patients were divided into four categories (18–44, 45–64, 65–74, and  $\geq 75$  years). Fewer patients were likely to achieve HbA1c targets of < 7% over time across all age subgroups. In the 45–64 years subgroup, the proportion of patients achieving these targets decreased the most, from 35.9% to 26.2% ( $P < 0.001$ ).

The trends in glycemic control across different geographic regions between 2009 and 2013 are presented in Supplementary Table 5, <http://links.lww.com/CM9/A857> and Supplementary Figure 2, <http://links.lww.com/CM9/A857>. During the observation period, the rate of adequate glycemic control in the South showed a decreasing trend. Nevertheless, the trends fluctuated in all other regions. The smallest decline in the rates of HbA1c control was 9.1% in the East, followed by 30.3% in the Central, 34.5% in the North, and 40.0% in the Northeast (all  $P < 0.001$ ). However, the rates of HbA1c control increased significantly from 28.3% to 38.0% in the Southwest and from 32.9% to 35.5% in the Northwest ( $P < 0.001$ ).

To further investigate the regional variations in glycemic control, the data of patients with T2DM from 2009 to 2013 were pooled. The pooled data of the seven geographic regions in China showed that the South region had the highest rate of adequate glycemic control (37.2% [36.8%, 37.5%]), followed by the Southwest region (34.7% [34.4%, 35.1%]). The lowest rate (26.4% [26.2%, 26.7%]) was observed in the Northeast region (all  $P < 0.001$ , except the  $P$  value [Northwest *vs.* East] = 0.029).

Multivariable logistic regression analysis revealed that the risk of inadequate HbA1c control in the other six regions was significantly higher than that in the South region (the reference region which had the highest rate of adequate glycemic control), after adjustment for age, sex, enrollment hospital, duration of diabetes, and BMI [Supplementary Figure 3, <http://links.lww.com/CM9/A857>]. The adjusted ORs varied from 1.11 (1.09, 1.13) in the Southwest region to 1.62 (1.59, 1.66) in the Northeast region.

Up to now, few researches have proved the trends and regional differences in glycemic control of patients with type 2 diabetes in China 10 years ago. Based on the analysis of the largest database of T2DM patients in China from 2009 to 2013, we found that both the age-standardized rate of patients with adequate glycemic control and that of those with HbA1c  $\geq 9\%$  declined considerably. Meanwhile, the proportion of patients with HbA1c 7–< 9% experienced a significant increase. Additionally, the increased risk of inadequate glycemic control varied greatly across geographic regions, which could not be explained by sex, age, enrollment hospital, duration of diabetes, and BMI. Our results may not be applicable to guide current clinical practice, but they can be compared with the current glycemic control in China, which indicates the change over the decade.

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### Conflict of interest

None.

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