

# Using Real-world data to Estimate the Changing Trends in the Prevalence and Incidence of type 2 Diabetes Mellitus in Xiamen of China,2014-2019

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## Research article

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# Abstract

**Background:** The prevalence of diabetes is increasing worldwide. Our study aimed to estimate the changing trends in the prevalence and incidence of diagnosed type 2 diabetes mellitus (T2DM) among Xiamen residents and the floating population using real-world data.

**Method:** We used real-world data from the System of Xiamen Citizens Health Information from 2014 to 2019 to estimate the changing trends in prevalence and incidence of diagnosed T2DM. The systems included the diagnosis of diabetes and the prescription of hypoglycemic drugs. Prevalent cases of T2DM were individuals who diagnosed T2DM and/or using hypoglycemic drugs. Incident cases were individuals with diagnosed T2DM and/or using hypoglycemic drugs in 2014 who had not diagnosed and/or no used one in the past.

**Results:** In 2014 and 2019, the prevalence of T2DM in Xiamen was 4.04% and 4.84%, respectively. In 2014 and 2019, the incidence of T2DM in Xiamen was 1.41% and 1.50%, respectively. There was an increase significant in the total of the prevalence and incidence of T2DM in Xiamen (0.80% (95% CI 0.76%-0.83%,  $P < 0.001$ ; 0.09% (95% CI 0.07-0.11),  $P < 0.001$ , respectively). The prevalence and incidence of T2DM in people aged 18-39 increased significantly, while the prevalence and incidence of T2DM in people aged 40-69 reduced significantly.

**Conclusions:** We found that there was an increasingly significant in the total of the prevalence and incidence of T2DM in Xiamen from 2014 to 2019. The prevalence and incidence of T2DM in Xiamen were significantly increased and showed a trend of younger age.

## Background

Diabetes is a series of chronic and progressive diseases caused by genetic and environmental factors that can lead to a chronic damage, dysfunction, and even failure of multiple organs. Owing to its high prevalence and related disability and mortality, thus diabetes has become a vital health problem worldwide [1, 2]. With the rapid development of the economy, the improvement of people's living standards, and the change of lifestyle in China in the past three decades, diabetes has become a chronic disease that seriously endangers people's health. Studies in recent years have shown that the global prevalence of diabetes is increasing significantly and varies by age, geography, regional economic disparities, ethnicity, etc. [3].

Over the past 40 years, the prevalence of diabetes in China has increased from less than 1–12.8% in 2018, and the prevalence of prediabetes is 35.2%, making it the country with the largest number of diabetes cases in the world, with type 2 diabetes mellitus (T2DM) accounting for more than 90% of patients [1, 4]. The total prevalence of diabetes in China from 2007 to 2008 was 9.7%, among which the prevalence of diagnosed diabetes was 4.1% in males and 3.5% in females [5]. The overall prevalence of diabetes in 2010 in China was 11.6%, with the prevalence of diagnosed diabetes at 3.5%, in males and females at 3.6% and 3.4%, respectively [3]. The overall prevalence of diabetes in 2013 in China was 10.9%, of which the prevalence of diagnosed diabetes was 4.0% (3.9% in males, 4.1% in males) [4].

Studies have revealed that the prevalence and the number of adults with diabetes have increased more in low - and middle-income countries than in middle - and high-income countries [6]. Rapid economic development and urbanization have resulted in an increasing burden of diabetes in many parts of the world [7]. As an important central city on the southeast coast of China, Xiamen's urbanization has reached up to 89.2%. In 2019, Xiamen's Gross Domestic Product (GDP) was close to 857.1 billion dollars, and the per capita GDP exceeded 20,000 dollars, which have reached the standards of developed economies. The data from the Xiamen Government Finance Bureau have shown that diabetes-related costs in Xiamen exceeded 43 million dollars in 2019, accounting for approximately 14.2% of the total annual cost of medical. The cost of diabetes care is statistically at least 3.2 times higher than the per capita medical

expenditure and up to 9.4 times higher in the case of diabetes-related complications, so the impact on individuals and society at large if the development of diabetes is not controlled promptly is incalculable [8, 9]. Therefore, exploring the prevalence and incidence of diabetes in Xiamen is of great significance to the management and China implemented healthcare reforms of diabetes in coastal areas of China. However, there are few data on the prevalence and incidence of diabetes in Xiamen. In this study, we used real-world data from the System of Xiamen Citizen Health Information to estimate the changing trends in the prevalence and incidence of diagnosed T2DM among Xiamen residents and the floating population.

## Methods

### Health system

The data of this study comes from the System of Xiamen Citizens Health Information, which is comprehensive information management and service platform jointly built by the Xiamen Municipal Health Bureau and China Mobile. All patients have a unique health insurance number and include information from all medical records of community hospitals, secondary and tertiary hospitals, and pharmacies, as well as diagnosis and medication information related to diabetes.

### Data

In this study, the real-world data from the System of Xiamen Citizens Health Information included the diagnosis of diabetes and usage records of hypoglycemic drugs, involving various types of hypoglycemic drugs such as Biguanides, Sulfonylureas, Thiazolidinediones, DPP-4, etc. All the included adult diabetic patients were diagnosed with T2DM according to the American Diabetes Association (ADA) criteria such as abnormal glycosylated hemoglobin and glucose levels. Prevalent cases of T2DM were individuals who diagnosed T2DM and/or using hypoglycemic drugs. To estimate the prevalence of T2DM in 2014 and 2019, we used data of System from 2014 and 2019, respectively. Incident cases were individuals with diagnosed T2DM and/or using hypoglycemic drugs in 2014 who had not diagnosed and/or no used one in the past. To estimate the annual incidence of T2DM in 2014 and 2019, we used the data from July 2013 to December 2014 and from July 2018 to December 2019, respectively.

### Statistical analysis

We counted the number of people in the System who met the T2DM definition and used this as a numerator. Population denominator data for the years 2014 and 2019 were population estimates derived by the government based on the 2013 and 2018 census, respectively. When calculating the prevalence of T2DM in Xiamen's floating population in 2019, the denominator was based on the data of the floating population in Xiamen released by the government in 2018. In this study, all included T2DM patients were analyzed according to gender and age, the age groups were 18–29 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years, and over 70 years. The information of each subgroup in 2019 was compared with that of 2014, and statistical analysis was carried out using SPSS18.0 and  $\chi^2$  test, with  $P \leq 0.05$  indicating that the difference was statistically significant.

## Results

### Prevalence of T2DM in Xiamen

In 2014, the resident population of Xiamen was 293,2637, and there were 118,468 T2DM patients, with a prevalence of 4.04% (95% CI 4.02–4.06), among which the prevalence was higher among women than men, at 4.72% (95% CI 4.68–4.75) and 3.37% (95% CI 3.34–3.40) respectively. The prevalence of T2DM increases with age, and it grows rapidly after

the age of 40. The number of patients aged 50–59 years old was the largest (29,073), with a prevalence of 8.47%(95%CI 8.38–8.56). The prevalence was as high as 17.54%(95%CI 17.33–17.74) in people over 70 years old. The prevalence of T2DM was 0.60%(95%CI, 0.58–0.62) among 18–29 years old (Table 1).

Table 1  
Prevalence of type 2 diabetes in 2014 and 2019

2014 population		2019 population						P value
	No. of diabetes	General	prevalent (%) (95%CI)	No. of diabetes	General	prevalent (%) (95%CI)	Difference in incidence (%) (95% CI)	
Total	118468	2932637	4.04(4.02–4.06)	140535	2905138	4.84(4.81–4.86)	0.80(0.76–0.83)	< 0.001
Sex								
Females	68641	1455557	4.72 (4.68–4.75)	78553	1423444	5.52 (5.48–5.56)	0.80 (0.75–0.85)	< 0.001
Males	49787	1477080	3.37 (3.34–3.40)	61982	1481694	4.18 (4.15–4.22)	0.81 (0.77–0.86)	< 0.001
Age, Years								
18–29	5143	857876	0.60 (0.58–0.62)	4141	530836	0.78 (0.76–0.80)	0.18 (0.15–0.21)	< 0.001
30–39	14378	775476	1.85 (1.82–1.88)	17594	836915	2.10 (2.07–2.13)	0.25 (0.21–0.29)	< 0.001
40–49	19945	620726	3.21 (3.17–3.26)	18513	627754	2.95 (2.91–2.99)	-0.26 (-0.33~-0.20)	< 0.001
50–59	29073	343264	8.47 (8.38–8.56)	29840	447403	6.67 (6.60–6.74)	-1.80 (-1.92~-1.68)	< 0.001
60–69	26348	194072	13.58 (13.42–13.73)	34804	270315	12.88 (12.75–13.00)	-0.70 (-0.90~-0.50)	< 0.001
≥ 70	23581	134473	17.54 (17.33–17.74)	35643	191915	18.57 (18.40–18.75)	1.04 (0.77 ~ 1.30)	< 0.001
(95%CI, 95% confidence interval)								

In 2019, the resident population of Xiamen was 2905138, with a total of 140535 T2DM patients, with a prevalence of 4.84% (95% CI 4.81–4.86). The prevalence of T2DM among women was also higher than men, with 5.52% (95% CI 5.48–5.56) and 4.18% (95% CI 4.15–4.22), respectively. Among the patients, 35643 people over the age of 70 years had the most cases of T2DM, with a prevalence of 18.57% (95%CI 18.40-18.75). The prevalence of T2DM was 0.78%(95%CI 0.76–0.80) among 18–29 years old. The prevalence of T2DM increases with age in both men and women, and increases sharply after age 50.

# The change in the prevalence of T2DM in Xiamen

There was an increase in the total of the prevalence of T2DM from 2014 to 2019, the difference in the increase was 0.80% (95% CI,0.76%-0.83%). The increase from 2014 to 2019 was 0.18% (95% CI,0.15%-0.21%) in 18–29 years, 0.25% (95% CI,0.21%-0.29%) in 30–39 years, and 1.04% (0.77%-1.30%) in ≥ 70 years. There was a reduction from 2014 to 2019 among 40–69 years. The reduction was 0.26% (95% CI,0.20%-0.33%) in 40–49 years, 1.80% (95% CI,1.68%-1.92%) in 50–59 years, and 0.70 (95% CI, 0.50%-0.90%) in 60–69 years (Table 1).

## Incidence of T2DM in Xiamen

In 2014, the incidence of T2DM in Xiamen was 1.41% (95% CI 1.39–1.42), and the incidence of females was higher than that of men, which was 1.59% (95% CI 1.57–1.61) and 1.16% (95% CI 1.14–1.18), respectively. The number of newly diagnosed T2DM patients aged 50–59 years was the largest, and the incidence was 3.04% (95% CI 2.98–3.10). The highest incidence of new cases that occurred at the age of over 70 years was 6.33%(95%CI 6.19–6.47). The incidence of T2DM was 0.26%(95%CI 0.25–0.27) at the age of 18–29 years (Table 2).

Table 2  
Incidences of type 2 diabetes in 2014 and 2019

	2014 population			2019 population			Difference in incidence (95% CI)(%)	P value
	No. of diabetes	General	prevalent (95%CI)(%)	No. of diabetes	General	prevalent (95%CI)(%)		
Total	39947	2843850	1.41(1.39–1.42)	41663	2780967	1.50(1.48–1.51)	0.09 (0.07–0.11)	< 0.001
Sex								
Females	22274	1404400	1.59(1.57–1.61)	22585	1355475	1.67(1.65–1.69)	0.08 (0.05–0.11)	< 0.001
Males	16673	1439450	1.16(1.14–1.18)	19078	1425492	1.34(1.32–1.36)	0.18 (0.15–0.21)	< 0.001
Age, Years								
18–29	2253	854868	0.26 (0.25–0.27)	1617	528056	0.31(0.29–0.32)	0.04 (0.02–0.06)	< 0.001
30–39	4932	765511	0.64 (0.63–0.66)	5455	823436	0.66 (0.65–0.68)	0.02(-0.01 ~ 0.04)	0.155
40–49	6980	606211	1.15 (1.13–1.18)	6664	610178	1.09 (1.07–1.12)	-0.06(-0.10~-0.02)	0.002
50–59	9758	321105	3.04(2.98–3.10)	9210	421281	2.19(2.14–2.23)	-0.85 (-0.93~-0.78)	< 0.001
60–69	8698	180487	4.82(4.72–4.92)	9732	238499	4.08 (4.00–4.16)	-0.74(-0.87~-0.61)	< 0.001
≥ 70	7326	115678	6.33 (6.19–6.47)	8985	159517	5.63 (5.52–5.75)	-0.70 (-0.88~-0.52)	< 0.001

In 2019, the incidence of T2DM was 1.50% (95% CI 1.48–1.51), and the incidence of females was still higher than that of males, which was 1.67% (95% CI 1.65–1.69) and 1.34% (95% CI 1.32–1.36), respectively. The number of newly diagnosed T2DM patients aged 60–69 years was 9732, with an incidence of 4.08% (95% CI 4.00–4.16). The incidence of new T2DM patients over 70 years old was the highest in the same year, as high as 5.63% (95% CI 5.52–5.75). The incidence of T2DM increases with age in both men and women and increases sharply after age 50.

## The change in the incidence of T2DM in Xiamen

There was an increase in the total of the incidence of T2DM from 2014 to 2019, the difference in the increase was 0.09% (95% CI, 0.07–0.11). The increase from 2014 to 2019 was 0.04% (95% CI, 0.02–0.06) in 18–29 years. There was a reduction from 2014 to 2019 over the age of 40. The reduction was 0.06% (95% CI, 0.02 ~ 0.10) in 40–49 years, 0.85% (95% CI, 0.78 ~ 0.93) in 50–59 years, 0.74% (95% CI, 0.61 ~ 0.87) in 60–69 years, and 0.70% (95% CI, 0.52 ~ 0.88) over the age of 70 years (Table 2).

## The prevalence of T2DM among the floating population

In 2019, there were 840,443 floating population in Xiamen, including 7,933 people with T2DM, with a prevalence of 0.94% (95% CI 0.92–0.97), and the prevalence in female was higher than that of males, which was 1.42% (95% CI 1.38–1.45) and 0.58% (95% CI 0.56–0.60), respectively. Among them, the age of 30–39 years old was the largest patients with T2DM, and the prevalence was 1.13% (95% CI 1.09–1.17). The prevalence of T2DM over 70 years old was the highest, as high as 2.64% (95% CI 2.26–3.01) (Table 3).

Table 3  
Prevalence of type 2 diabetes in the floating population in 2019

	No. of diabetes	Population	Estimate (%)	95% CI
Total	7933	840443	0.94	0.92–0.97
Sex				
Females	5203	367754	1.42	1.38–1.45
Males	2730	472689	0.58	0.56–0.60
Age, years				
18–29	1388	307385	0.45	0.43–0.48
30–39	3010	265476	1.13	1.09–1.17
40–49	1589	143763	1.11	1.05–1.16
50–59	1229	86816	1.42	1.34–1.49
60–69	532	30017	1.77	1.62–1.92
≥ 70	185	7016	2.64	2.26–3.01

## Discussion

In this study, we found that there was an increasingly significant in the total of the prevalence and incidence of T2DM in Xiamen from 2014 to 2019. The prevalence and incidence of T2DM in people aged 18–29 years and 30–39 years increased significantly from 2014 to 2019, while the prevalence and incidence of T2DM in people aged 40–69 years

reduced significantly from 2014 to 2019, indicating that the prevalence and incidence of T2DM in Xiamen were significantly increased and showed a trend of younger age.

The result of our study was consistent with the concept that diabetes tends to be greater among the young in Asia [10]. The results showed that one in five adult patients was diagnosed with T2DM before age 40 and that younger patients with T2DM had poor awareness of disease management, suggesting that more young people will suffer from T2DM in the future [10]. More focused efforts are needed to improve risk factor control strategies for people under 40 years of age, including prevention measures for obesity and inadequate lifestyles, and younger screening for diabetes for those at risk. Compared with the prevalence of T2DM in 2014, the rapid increase in prevalence in 2019 is closely related to the economic development of Xiamen in recent years, the improvement of people's living standards, the acceleration of urbanization, and the aging population, etc. The GDP of Xiamen in 2014 was 46.8 billion dollars, which increased by 83% to nearly 85.7 billion dollars in 2019. With the development of economy, people's lifestyles such as dietary structure have undergone major changes, the proportion of cereal intake has decreased, the proportion of meat and fat has increased, fat intake has increased, physical exercise have decreased, all of these can promote the occurrence and development of overweight, obesity and diabetes [11, 12]. This shows that the situation of prevention and treatment of diabetes in Xiamen is very serious.

This study found that the prevalence of T2DM in Xiamen was 4.84% in 2019. The prevalence among men and women was 4.18% and 5.52%, respectively, which were higher than the prevalence of diagnosed diabetes in 2007, 2010, and 2013 in China. A large national study in China published recently showed that 11.2% of adults (according to WHO standards) or 12.8% of adults (according to ADA standards) had diabetes in 2018, as a result, China was estimated to be 129.8 million diabetic patients (70.4 million males and 59.4 million females), of which the prevalence of diagnosed diabetes was 6.0% (6.4% in men, 5.6% in women) (16). According to the study, the prevalence of diagnosed diabetes in urban and southern China was 7.1% and 5.8% respectively, both higher than the prevalence of T2DM in Xiamen in our study.

The lower prevalence and incidence of T2DM in Xiamen compared to the studies mentioned above may be attributed to many factors. There is considerable evidence that Western diets characterized by meat are significantly associated with T2DM, while Mediterranean diets characterized by plants are associated with a low risk of diabetes [13, 14]. A meta-analysis has concluded that the intake of red meat and processed meat is positively associated with the risk of T2DM, while the intake of aquatic products has no significant correlation with the risk of T2DM [15]. Our study showed that the prevalence of T2DM in Xiamen in 2019 was lower than the prevalence of diagnosed diabetes in China in 2018 (4.84% vs 6.0%), which may be related to the fact that Xiamen is located in the coastal area of China, where the seafood is abundant and diverse, and the per capita daily intake of aquatic products of Xiamen residents is higher than the average level of all over the world. Xiamen's urbanization process is advancing by leaps and bounds. As one of the most advanced cities in China, Xiamen's green coverage is up to 45%. The ecological civilization index ranks first and reaches the world's advanced level. Not only that, but Xiamen citizens also admire national sport, especially badminton and marathon. The Xiamen Health Trail was also completed in 2019, aiming to provide more convenient places for people to play sport and improve their physical quality. Xiamen provides free medical examination services for the elderly every year. And the average life expectancy of Xiamen residents reached 80.45 years in 2017.

The prevalence of diabetes among the floating population is lower than that of the general population, but considering the growth rate of the floating population and the poor disease management awareness among the floating population, the potential threat posed by diabetes among this group cannot be ignored. In 2017, a study calculated that the prevalence of diabetes among the mobile population in China was 5.1% (95% CI 4.9–5.3), and the prevalence was higher among women than men [16]. Xiamen is a developed coastal economic region with a large number of migrant workers and a large migrant population, but there are few reports on the prevalence of diabetes among the floating population.

This study explored this issue for the first time and found that in 2019, the number of floating population in Xiamen was 840,443, and the prevalence of T2DM was 0.94%(1.42% in women, 0.58% in men). The age of 18–29 years people was the most floating population, with a prevalence of 0.45%. Those over 70 years old have the highest T2DM prevalence, which was 2.64%. It can be seen from the above data that the prevalence of diabetes among the floating population in Xiamen is far lower than the national average level, which may be attributed to the following reasons: 1) Most of the floating population in Xiamen are working people with good physical fitness and great exercise intensity, and there are fewer obese or overweight people, thus reducing the risk of diabetes. 2) Most of the floating population who come to Xiamen does not have medical insurance in Xiamen, so it may not be possible to record diagnosed diabetes cases into the system of Xiamen citizen health information. The government and the hospital should offer T2DM knowledge lectures or online classes for the floating population in Xiamen, to improve their self-management awareness of T2DM, and effectively control the epidemic trend of T2DM in the floating population.

The strength of our study included a large sample of a population-based longitudinal study to direct comparison of T2DM prevalence and incidence from 2014 to 2019 in population in Xiamen. The prevalence and incidence of T2DM in this study were evaluated based on real and reliable data. There were also several limitations to our study. First, the study is limited by the lack of information on patients with undiagnosed diabetes. Second, there may be some patients with T2DM who do not receive medication and be only controlled by diet. Finally, we only analyzed T2DM and had no information on other types of diabetes including type 1 diabetes.

## **Conclusion**

In summary, Our study used real-world data from the system of Xiamen citizen health information to estimate the trend in the prevalence and incidence of T2DM. We found that there was an increasingly significant in the total of the prevalence and incidence of T2DM in Xiamen from 2014 to 2019. The prevalence and incidence of T2DM in people aged 18–39 years increased significantly, while that in people aged 40–69 years reduced significantly from 2014 to 2019, indicating that the prevalence and incidence of T2DM in Xiamen were significantly increased and showed a trend of younger age. This approach affords to monitor epidemic trends in real-time, thus providing a basis for health policies and health service plans.

## **Declarations**

## **Ethics approval and consent to participate**

The study was approved by the research Ethics Committee at the First Affiliated Hospital of Xiamen University. The system of Xiamen citizen health information is a collaborative platform for medical institutions, with access to raw data under the authority of the Xiamen Municipal Health Commission.

## **Availability of data and materials**

Data sharing is not applicable to this article, as no datasets were generated or analyzed during the current study.

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# Authors' contributions

All of the authors contributed to the design of the study. XJ L contributed to the study conception and design. While WH, QS X led data collection, analysis, and writing of the manuscript, LH and LS Y led the supervision of all these steps. TW, XL S, and GH Y have contributed to the writing of the manuscript.

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# Consent for publication

Not applicable.

# Conflict of Interest

The authors declare that they have no competing interests.

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