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The epidemic of diabetes and its impact on cardiovascular health in contemporary China

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KEYWORDS
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Summary
Objectives: To examine the epidemic of diabetes and its impact on cardiovascular disease (CVD) in China.
Methods: We searched PubMed and local databases for studies published since 1980. Information on study design, sample characteristics, diagnosis, and prevalence of diabetes were extracted using a standardized protocol. We calculated average annual increases in rates and the population attributable risk of CVD due to Type 2 diabetes (T2D).
Results: Nationwide survey data indicate that the prevalence of T2D in Mainland China has increased from 0.67% in the early 1980s to 3.21% in the mid-1990s and to 5.5% in 2001–02. A 2001–02 national survey among people aged 35–74 showed that the prevalence was 5.2% in men and 5.8% in women. The prevalence increases with age and is higher in urban- than rural areas. The annual increase in the rate of T2D and impaired glucose tolerance were 0.70% and 0.64% point, respectively. People in Hong Kong and Taiwan (approximately 8–10%) had a higher prevalence of T2D than on the Mainland. Chinese adults with diabetes were 1.7 times more likely to develop CVD than those with normal fasting glucose. We estimated that 3.3% of CVD in China is attributable to T2D.
Conclusions: The prevalence of T2D has steadily increased in China over the past two decades, although it remains lower than many industrialized countries. Considerable differences in prevalence exist across regions and population groups. Urban and higher-income groups are affected the most, in particular, due to changes in lifestyle and a rising obesity epidemic. Timely national strategies are needed for the prevention, screening, and treatment of T2D.

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Introduction

Since the economic reform initiated in the late 1970s, China has experienced many dramatic social economic developments, which have significantly affected the daily lives as well as the health of its citizens [1—3]. A growing number of studies show that the prevalence rates of obesity and Type 2 diabetes (T2D) have increased dramatically in China, especially in the past decade [4]. As has been extensively studied, obesity is a serous risk factor for both T2D and cardiovascular diseases (CVD) in addition to many other chronic diseases [5,6]. With the increase in obesity, related chronic diseases have also increased over the past decade and obesity has become an important preventable cause of deaths in China [4]. National surveys and statistics along with findings from other large population-based surveys such as the China Multicenter Collaborative Study of Cardiovascular Epidemiology show that CVD has already become the leading cause of death for both men and women in China [7]. China is currently undergoing rapid demographic, social, economic, and health shifts that may further increase the burden of CVD [8].

Nationally representative surveys show that the combined prevalence of overweight and obesity in China has increased form 14.6% to 21.8% between 1992 and 2002 based on the World Health Organization's (WHO) recommended body mass index (BMI) cut point of 25 [4]. The prevalence of hypertension increased from 11.3% in 1991 to 27.2% in 2000 [4]. T2D has become an important public health challenge in economically developing countries including China [9,10]. The prevalence of T2D in the Chinese adult population has increased from 0.67% in the early 1980s to 5.5% in 2001—2002 [11]. The number of diabetic patients is projected to increase from 20.8 million in 2000 to 42.3 million in 2030 in China [9,12]. On the other hand, although the rising incidence of Type 1 diabetes (T1D) is becoming a global phenomenon [13], the incidence of T1D in China seems to be the lowest ever reported in the world [14,15].

To our knowledge, few studies have systematically examined the trends in the prevalence of T2D and T1D in China. The present study aims to study the trends in diabetes and its impact on the risk of cardiovascular health in China. We focused on representative data collected in Mainland China, but also examined the situation in selected major cities in China and Hong Kong and Taiwan. The latter places where the economy is more developed and the residents are having a more Westernized diet and sedentary lifestyles, may help shed light on the future situation in Mainland China [16].

Materials and methods

Data inclusion criteria

Cross-sectional and longitudinal studies published in Chinese and English that examined the prevalence or incidence of diabetes in China were examined. In Mainland China, we focused on data collected in nationwide surveys to examine the trend for diabetes over time. In addition, we highlighted the situation in Beijing and Shanghai, which are the two largest cities in China and may help show the situation in more economically developed areas in Mainland China. In general, the residents of these areas have been experiencing more dramatic changes in their lifestyles and a greater influence of Western culture and more chronic diseases than their counterparts in other regions. Furthermore, T2D-related large scale studies in Hong Kong and Taiwan were also included.

Search strategies

To identify related studies, we searched PubMed and local databases in Mainland China and Taiwan for studies published from January 1980 to July 2007, including those published in English and Chinese. Several key terms were used in the search process, such as China, Hong Kong, Taiwan, diabetes, hypertension, cardiovascular disease, fasting glucose, and metabolic syndrome. Titles and abstracts of studies uncovered by the electronic searches were examined on screen. Papers of those studies which could not be excluded on the basis of the abstract were obtained in full and reviewed for suitability for inclusion. In addition, a number of studies identified in the course of reading or brought to our attention by colleagues and experts that we consulted were also included.

Classification and diagnosis of diabetes

On the basis of its etiology, diabetes is classified into two major types: T1D, caused by immunological destruction of pancreatic islets, is characterized by absolute insulin deficiency and usually occurs in childhood. T2D begins in the middle age or earlier and is characterized by deficient insulin secretion and/or insulin resistance [17,18].

The diagnostic criteria for T2D used by studies we included were summarized in Table 1. Most of

Table 1 Diagnostic criteria for Type 2 diabetes (T2D).

Category	China (1980)* [26]	WHO (1980) [20]	WHO (1985) [21]	WHO (1999) [19]	ADA (1997) [18]
T2D	FPG > 7.3 or 2 h PG > 11.1	FPG ⩾ 7.8 or 2 h PG ⩾ 11.1	FPG ⩾ 7.8 or 2 h PG ⩾ 11.1	FPG ⩾ 7.0 or 2 h PG ⩾ 11.1	FPG ⩾ 7.0
IGT	FPG ⩽ 7.3 and 2 h PG ⩽ 11.1	FPG < 7.8 and 2 h PG < 11.1	FPG < 7.8 and 2 h PG < 11.1	FPG < 7.0 and 2 h PG < 11.1	7.8 ⩽ 2 h PG < 11.1

T2D: Type 2 diabetes; IGT: impaired glucose tolerance; WHO: World Health Organization; ADA: American Diabetes Association.
* One hundred grams of glucose for oral glucose tolerance test (OGTT) instead of 75-g glucose.

the previous studies used the criteria recommended by the WHO (WHO, 1980, 1985, 1999) [19—21] or American Diabetes Association (ADA, 1997) [18]. Usually, normal fasting plasma glucose (FPG) is defined as <110 mg/dl (6.1 mmol/l). Impaired glucose tolerance (IGT) is defined as FPG <126 mg/dl (7.0 mmol/l) and 2 h PG after a 75 g oral glucose challenge 140—199 mg/dl (7.8—11.1 mmol/l). Impaired fasting glucose (IFG) is defined as FPG from 110 mg/dl (6.1 mmol/l) to 125 mg/dl (6.9 mmol/l) [22]. Diabetes includes previously diagnosed and newly diagnosed/undiagnosed/unknown diabetes. The undiagnosed individuals are those who do not know that they are suffering from diabetes until they are tested or screened and diagnosed by using the relevant diagnostic criteria. The definition of T1D cases requires that patients are diagnosed by a physician and placed on daily insulin injections aged 0—14 years at the time of diagnosis.

Diagnosis of cardiovascular diseases

CVD include coronary heart disease (CHD) and stroke. According to the International Classification of Diseases (ICD-9) codes, CHD is defined as first incidence of acute myocardial infarction (MI), coronary death, nonfatal ischemic heart disease, nonfatal heart failure, sudden death, and other coronary deaths. Stroke events include patients presenting with clinical signs and symptoms suggestive of subarachnoid hemorrhage, intracerebral hemorrhage, or cerebral infarction [23].

Statistical analysis

To facilitate comparisons of the trends across studies based on data gathered over different survey periods, we calculated the annual increase in rate by fitting linear regression models using prevalence as the outcome variable and survey time as the independent variable (e.g., prevalence at time t = intercept + beta*t). Beta represents the average annual increase in prevalence.

The model was fitted based on findings from 3 national surveys conducted in mainland China in 1994 [24], 1997 [25], and 2001 [10]. We chose the 1997 survey data vs. the 1998 survey [27] because the 1997 survey's sample size was much bigger (42,751 vs. 29,558), although they were conducted only 1-year apart. In addition, the age range of the 1997 study population (20—74 years) was wider and more representative than that of the 1998 survey (40—99 years). We did not use the estimate based on the 2002 China National Health and Nutrition, but chose to use the estimate provided in the 2001 InterASIA study, because we believe the latter provides a more accurate estimate of China's prevalence of T2D owing to its strengths. For example, it included a large representative sample, had a high response rate, and applied a vigorous quality assurance programme and standard protocols and instruments for data collection and lab tests [10].

In addition, based on the estimated annual increase in rates, we projected the prevalence of T2D and IGT for the years of 2015 and 2030. Our projections indicate what the future prevalence of diabetes might be in China if the trend continues at a similar rate to that observed previously and if there are no dramatic changes in the population age distribution or in intervention efforts. Our goal was not to project what the actual situation will be in the future, which can be affected by many factors and uncertainties. We also calculated population-attributable risk (PAR) of T2D and IFG for CVD based on the recent prevalence of T2D and IFG [10] and the hazard ratio (HR) reported in previous studies [5,10]. Data analysis was conducted in SAS Version 9.1 (SAS Inc, Cary, NC, USA).

Results

A total of 20 studies that have studied T2D were included in our study. Of these, 14 studies were conducted in Mainland China (6 national studies, 3 in Beijing, and 5 in Shanghai), 2 in Hong Kong, and 4 in Taiwan. The details of these studies are shown in Table 2.

Table 2 Characteristics of cross-sectional studies on the prevalence of Type 2 diabetes (T2D) in Mainland China, Hong Kong, and Taiwan.

No.	Author, publication year	National or local	Year of data collection	Sample size	Age (year)	Diagnostic criteria	Prevalence (%)		Comments/Notes
							T2D	IGT/IFG	
Mainland China Nationwide or national									
1	Zhong [26], 1982	National, 13 provinces included	1980	304537,160195 men	0–90	1980 China Criteria [26]	T: 0.61 M: 0.63; F: 0.59 Age-standardized: 0.67	T: 0.42	Age-standardized to 1964 Chinese population
2	Pan et al. [24], 1997	National, 19 provinces included	1994	213515, 113002 men	25–64	1985 WHO Criteria [21]	T: 2.28 M: 2.21; F: 2.40 Age-standardized: 2.51	T: 2.10 M: 2.07; F: 2.07 Age-standardized: 3.20	Age-standardized to 1990 Chinese population
3	Wang et al. [25], 1998	National, 11 provinces/regions included	1995–1997	42751, 18631 men	20–74	1985 WHO Criteria [21]	M: 3.40; F: 3.79 Age-standardized: 3.21	M: 4.94; F: 5.46 Age-standardized 4.76	Age-standardized to 1990 Chinese population
4	Yang Z[27], 2002	National, 12 provinces included	1997–1998	29558, 13402 men	40–99	1985 WHO Criteria [21]	T: 5.7 M : 5.4; F: 5.9 Urban: 6.8*; Rural: 3.8 Age-standardized: 5.89	T: 5.8; M: 6.1; F: 5.5 Urban: 6.1* Rural: 5.3 Age-standardized 5.9	Prevalence was higher in urban than in rural area;
5	Gu et al. [10], 2003	National, 10 provinces included	2000–2001	15839, 7684 men	35–74	1997 ADA Criteria [18]	Diagnosed:1.3 Undiagnosed: 4.2 T: 5.5 M: 5.2; F: 5.8 Age-standardized: 5.2 M: 4.9; F: 5.4 North: 7.4*; South: 5.4 Urban: 7.8*; Rural: 5.1	IFG: 7.3 Age-standardized: 8.2*; F: 6.9 North: 7.9 South: 7.1 Urban: 7.7 Rural: 7.4	1) Prevalence was higher in north than in south and in urban than in rural areas; 2) Three out of every four T2D patients are undiagnosed, 3) Age-standardized to 2000 Chinese population
6	Li et al. [60], 2005	National, 31 provinces included	2002	209849, 101377 men	18–	1999 WHO Criteria [19]	T: 2.6 M: 2.5; F: 2.7 Urban: 4.5* Rural: 1.8	IFG: 1.9 M: 2.2; F: 1.8 Urban: 2.7 Rural: 1.6	1) Prevalence was higher in urban than in rural areas; 2) Prevalence increased with age; 3) Age-standardized to 2000 Chinese population
Beijing and Shanghai									
7	Xu et al. [61], 1982	Beijing	1980	39896, 21431 men	0–79	1980 WHO Criteria [20]	T: 0.73 M: 0.81; F: 0.63 Age-standardized: 1.10	T: 0.43 M: 0.43; F: 0.42	1) No gender difference; 2) Age-standardized to 1964 Chinese population
8	Yang Z. [27], 2002	Beijing	1997–1998	1540, 864 men	40–99	1985 WHO Criteria [21]	T: 11.6 Age-standardized: 10.4 M: 9.7; F: 12.8 Urban : 13.6*; Rural: 6.9	T: 12.2 Age-standardized: 11.3; M:11.7;F:12.6 Urban: 12.3; Rural: 11.9	1) Prevalence was higher in urban than in rural area; 2) Prevalence increased with age
9	Pang et al. [62], 2005	Beijing	2002	30402, 14871 men	⩾15	1999 WHO Criteria [19]	T: 7.7 M: 6.7; F: 8.6	NA	Prevalence was higher in women than in men
10	Group [63],1980	Shanghai	1980	101624	0–	1980 China Criteria [26]	T: 1.01 M: 1.05; F: 0.97 Overt DM: 0.71 Latent DM: 0.30 Age-standardized: T: 0.93 M: 0.99; F: 0.88	NA	1) Prevalence increased with age; 2) Age-standardized to 1978 Shanghai population
11	Shi et al. [41], 1998	Shanghai	1994	13632, 6763 men	⩾25	1985 WHO Criteria [21]	T: 2.33 (0.67 known, 1.66 unknown T2D) Age-standardized: M: 2.54; F: 2.14	T: 1.30; M:1.42; F: 1.31	Prevalence standardized with the 1994 Shanghai census

12	Yang [27], 2002	Shanghai	1997—1998	2973, 1219 men	40—99	1985 WHO Criteria [21]	T: 6.9 Age-standardized: 6.1 Men: 6.0; Women: 7.5	T: 4.5 Age-standardized: T: 4.4 M: 5.2; F: 4.0	Prevalence increased with age
13	Jia et al. [6], 2002	Shanghai	1998—2000	2776, 1106 men	20—94	1999 WHO Criteria [19]	Age- and gender-adjusted: 9.76 M: 11.03*; F: 8.92	NA	Prevalence was higher in men than in women
14	Li et al. [64], 2006	Shanghai	2004	11589, 4621 men	15—74	1999 WHO Criteria [19]	T: 8.6; M: 8.9; F: 8.4; Urban: 11.2 M: 12.2*; F: 10.6 Rural: 5.3 M: 4.6; F: 5.7 Age-standardized: 6.2	IGT T: 6.9; M: 6.4; F: 7.3; Urban: 6.4; Rural: 7.5 IFG T: 1.0; M: 1.0; F: 1.0; Urban: 1.2; Rural: 0.8; Age-standardized IGT: 5.1; IFG: 0.8	1) Prevalence increased with age; 2) Prevalence was higher in urban than in rural areas; 3) Age-standardized to 2000 Chinese population
Hong Kong									
15	Cockram et al. [34], 1993	Hong Kong	1991	1513, 910 men	18—64	1985 WHO Criteria [21]	T: 4.5 M: 5.1; F: 3.6 Age-standardized: 7.7; M: 9.0; F: 6.3	T: 7.3 M: 7.4; F: 7.1 Age-standardized: M:11.2; F: 8.8	Age-standardized to 1993 world population
16	Lam et al. [33], 2000	Hong Kong	1994—1996	2664, 1316 men	25—74	1985 WHO Criteria [21]	Diagnosed: M: 3.0; F: 3.7 Undiagnosed M: 6.4; F: 5.9 Age-standardized: 35-64 age group M: 9.5; F: 10.2	M: 14.4; F: 17.0	1) Prevalence increased with age; 2) Age-standardized to Segi's 1957 world population
Taiwan									
17	Wu et al. [65], 1986	Northern Taiwan (Taipei city)	1985	2206	40—69	1980 WHO Criteria [20]	T: 6.0; M: 5.5*; F: 6. 4 40-49y: 3.0; 50-59y: 6.5; 60-69y: 9.3	T: 2.5	Prevalence was higher in women than in men;
18	Lu et al[36], 1998	Southern Taiwan (Tainan city)	1996	1638, 780 men	⩾20	1985 WHO Criteria [21]	T: 9.0 M: 10.3; F: 7.9 Diagnosed: 4.8 M: 5.3; F: 4.4 Undiagnosed: 4.2 M: 4.9; F: 3.5 Age-standardized: 9.2 diagnosed: 4.8 undiagnosed: 4.4 M: 10.4; F: 8.1	T:14.0 M: 13.8; F: 14.1 Age-standardized: 15.5 M:15.0; F: 15.9	1) No gender difference; 2) Prevalence increased with age; 3) Age-standardized to Segi's world population
19	Pan et al. [40], 2003	Taiwan-wide	1993—1996	5256, 2518 men	⩾4	1997 ADA Criteria [18]	<19 yrs: 0; ⩾19 yrs: M: 3.7; F: 6.3 19-44 yrs: M: 1.5; F: 0.5 45-64 yrs: M: 7.9; F: 12.3 ⩾65 yrs: M: 7.8; F: 19.6	NA	1) Prevalence was higher in women than in men; 2) Prevalence increased with age; 3) Taiwan wide health survey
21	Chang et al. [35], 2005	Taiwan-wide	2001	8988	⩾40	Confirmed by medical professionals	8.5	NA	2001 Taiwan wide health survey

T2D: Type 2 diabetes; IGT: impaired glucose tolerance; IFG: impaired fasting glucose; T: total; M: male; F: females; WHO: World Health Organization; ADA: American Diabetes Association; NA, not available.

Mainland China

Type 2 diabetes (T2D)

Current prevalence: The current prevalence of T2D in Mainland China is much higher than in the past [10,24—26]. Based on the data collected in 2000—01 in the International Collaborative Study of Cardiovascular Disease in Asia (InterASIA) from a nationally representative sample of 15540 adults aged 35-74 years, the prevalence was 5.5% (1.3% for self-reported diagnosed diabetes, 4.2% for undiagnosed diabetes) according to the 1997 ADA criterion [10]. The prevalence of undiagnosed diabetes was more than 3-fold higher than that of diagnosed diabetes. Overall, 5.2% men and 5.8% women had T2D.

The prevalence of T2D increased with age. Data obtained from another national survey including 12 provinces in 1997—98 show a higher prevalence of T2D and IGT in older groups, particularly among those aged 65 years and over (Fig. 1). For example, the prevalence increased from 2.0% for ages 40—44 years to 11.2% for ages 70—74 years based on the 1985 WHO criterion. There are also considerable urban-rural and regional differences in the prevalence. The InterASIA study shows that the prevalence was higher in urban than in rural areas, and in the North than in the South in all age groups (Fig. 2). The age-standardized prevalence was 7.8% vs. 5.1% among urban and rural residents ($P < 0.001$), while it was 7.4% in northern vs. 5.4% in southern residents ($P < 0.001$) [10].

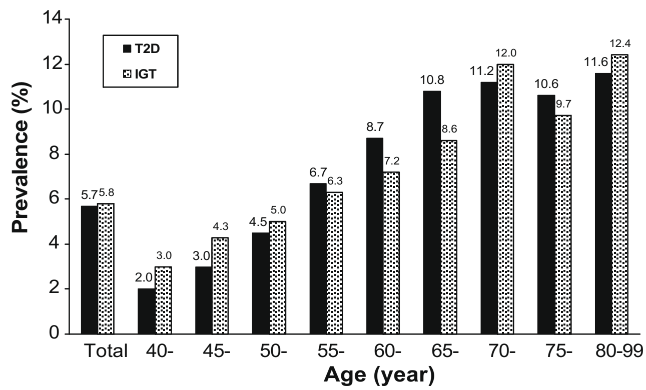


Figure 1 Prevalence of Type 2 diabetes (T2D) and impaired glucose tolerance (IGT) among adults aged 40—99 years in 12 provinces in Mainland China, by age (1997—1998) $N = 29558$. Based on World Health Organization (WHO) 1985 criteria. (Data source: Yang, 2002.) [27].

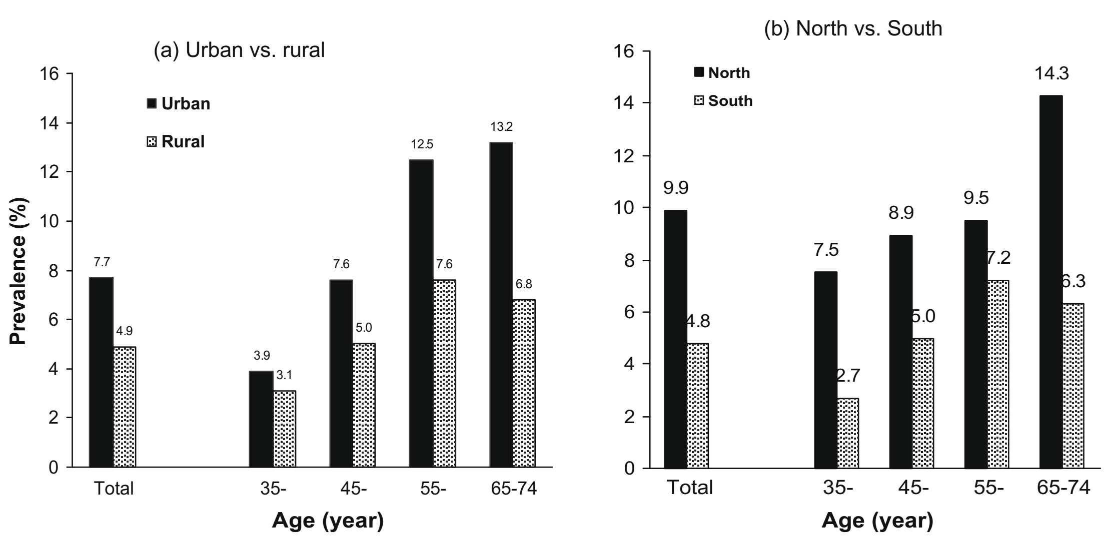


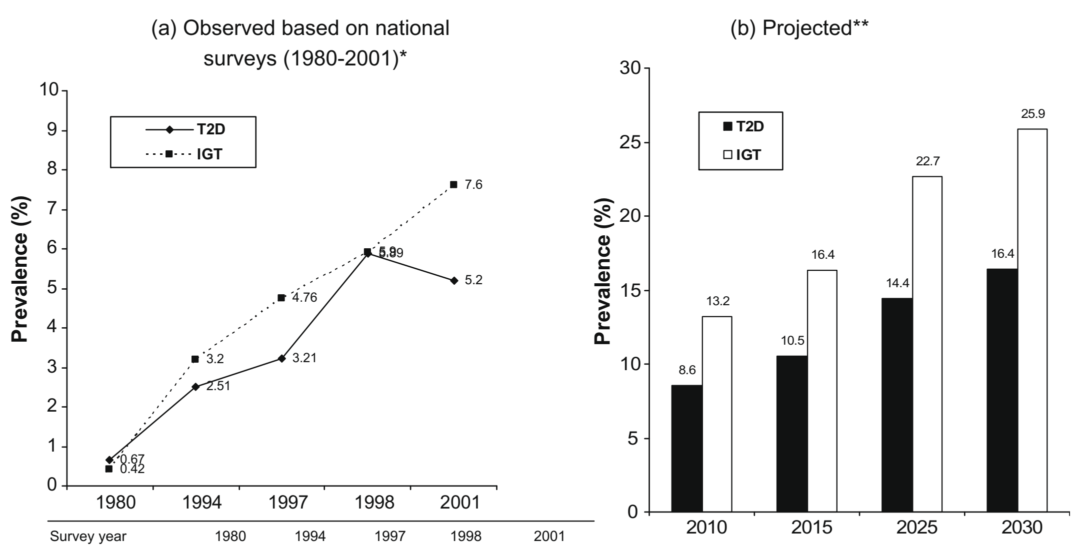
Figure 2 Urban-rural and regional differences in the prevalence of Type 2 diabetes among adults aged 35—74 years in 10 provinces in Mainland China, by age (2000—2001) (a) Urban vs. rural (b) North vs. South $N = 15540$. Based on American Diabetes Association (ADA) 1997 criterion [18]. (Data source: Gu et al., 2003 [10].)

Beijing and Shanghai: Available representative data show that the prevalence of T2D and IGT in Beijing and Shanghai is much higher than the national average. The 2002 China National Nutrition and Health Survey, a nationally representative survey, shows that in Beijing, the prevalence among residents aged ⩾15 years was 7.7% based on the 1999 WHO criterion.[62] The age-standardized prevalence of T2D and IGT among those aged 40 years and older in 1998 was 10.4% and 11.3%, respectively according to the 1985 WHO criterion [27]. In Shanghai, the age-standardized prevalence of T2D and IGT among people aged 15—74 years in 2004 was 6.2% and 5.1% based on the 1999 WHO criterion, respectively. In general, the prevalence in Beijing is slightly higher than in Shanghai, which may be due to differences in people’s lifestyles.

Trends in the prevalence: Although previous studies based on the data collected over time have often used different criteria for the diagnosis of T2D, such data allow examination of the general time trends in the prevalence of T2D. As shown in Fig. 3, the prevalence of T2D and IGT has increased in Mainland China based on the nationwide surveys conducted over the past two decades. We focused on those studies that provided better comparable data based on the age of the study respondents and diagnostic criteria. From 1980 to 2001, there was an upward trend in the prevalence. The age-standardized prevalence of diabetes and IGT was reported to be less than 1% among a nationally representative sample of 304,537 subjects in 1980 [26]. The 1994 China National Diabetes Survey examination of 2,153,515 men and women yielded prevalence estimates for diabetes and IGT of 2.5% and 3.2%, respectively [28]. In general, the prevalence of IGT was higher than that of diabetes.

Our regression analysis based on three national diabetes surveys [10,24,25], indicates that the annual increase in rates of diabetes and IGT were 0.39% and 0.63% point, respectively. Based on these estimates, we projected that for the year 2015, the prevalence of T2D and IGT would be 10.5% and 16.4%, respectively. For the year 2030, the corresponding figures were 16.4% and 25.9%, respectively.

Beijing and Shanghai: In general, the prevalence rates in Beijing and Shanghai and their average annual increase were higher than the national averages. During 1980—2002 in Beijing, the prevalence of T2D increased six times, from 1.1% to 7.7%. The average annual increase in rate was 0.33 percentage point. In Shanghai, during 1994—2004, the prevalence more than doubled, from 2.3% to 6.2% with an annual increase in the rate of 0.39% point.



Survey year	1980	1994	1997	1998	2001
Year for standardization	1964	1990	1990	NA	2000
Criterion for diabetes	1980,China	1985,WHO	1985,WHO	1985,WHO	1997,ADA

Figure 3 Observed and projected time trend in the prevalence of Type 2 diabetes (T2D) and impaired glucose tolerance (IGT) in Mainland China: 1980 to 2030. *Data source: Zhong, 1982 [26] (China/Lanzhou 1980 criterion); Pan et al., 1997 [24] (WHO 1985 criteria); Wang et al, 1998 [25] (WHO 1985 criteria); Yang, 2002 [27] (WHO 1985 criteria); Gu et al., 2003 [10] (ADA 1997 criteria). **Our projection was based on linear regression models and used the prevalence estimates from 3 national surveys conducted in 1994 (Pan et al., 1997) [24], 1997 (Wang et al., 1998) [25], and 2001 (Gu et al., 2003) [10]. The data fit the linear models very well, $R2 = 0.97$ for T2D and $R2 = 0.99$ for IGT.

Type 1 diabetes (T1D)

National situation: Based on a registration system of T1D monitoring >20 million children in 22 centers nationwide in Mainland China during 1985—1994, which was part of the WHO's Multinational Project for Childhood Diabetes (Diamond) project [29,30], the crude incidence rate (per 100,000/year) was 0.48 and the overall ascertainment-corrected diabetes incidence rate was 0.51. The age-specific incidence rate was lowest for those 0—4 years old and highest for those aged 10—14 years, although the study did not provide age-specific rates. In general, the incidence rate was higher in the north and the east, with a range between 0.79 and 0.23 (Fig. 5). Boys had a slightly lower rate, 0.47 vs. 0.59. In addition, the data show large ethnic differences in the incidence rate. The highest was among Mongols (=1.82) and the lowest was among Zhuangs (=0.32). Fig. 6a shows the time trend in the T1D incidence among children <15 years during 1990—94. The rates seemed stable over the years.

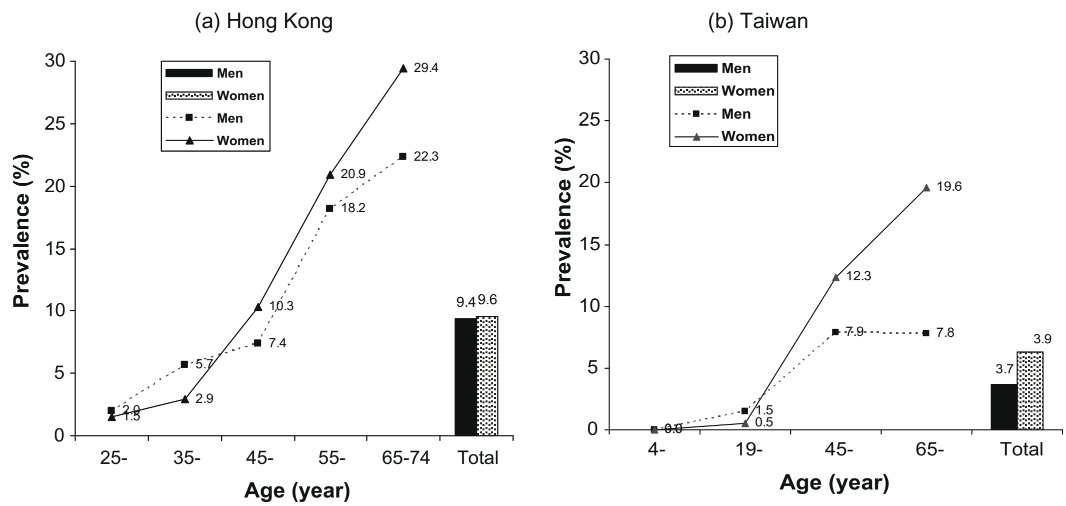


Figure 4 Prevalence of Type 2 diabetes in Hong Kong (1994—1996) and Taiwan (1993—1996), by age (a) $N = 2664$ *Based on WHO 1985 criterion (Data source: Lam et al., 2000 [33]). (b) $N = 5256$ *Based on ADA 1997 criterion (Data source: Pan et al., 2003 [40]).

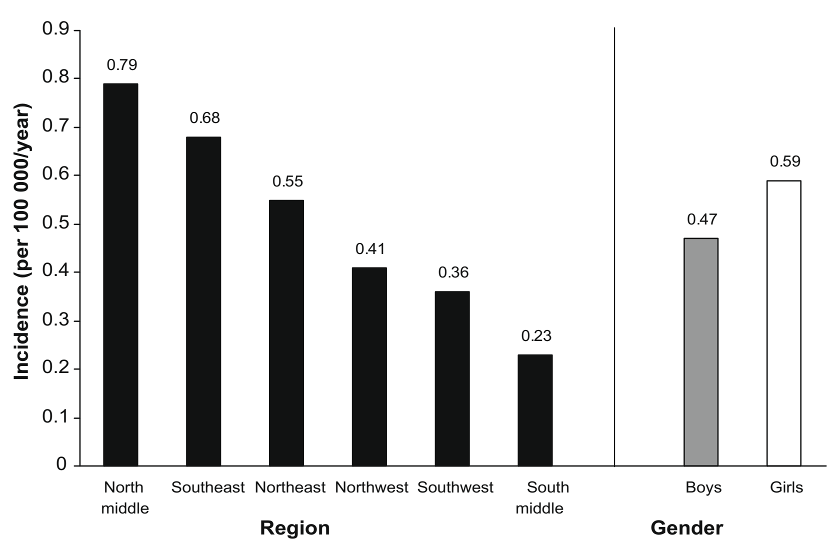


Figure 5 The incidence rate (per 100,000/year) of Type 1 diabetes in children aged <15 years in Mainland China, by region and gender (1985—1994). As part of the WHO's Multinational Project for Childhood Diabetes (WHO Diamond), the Chinese IDDM registry is based on a nationally representative sample of children aged <15 years in Mainland China. (Data source: Yang et al., 1998 [30]).

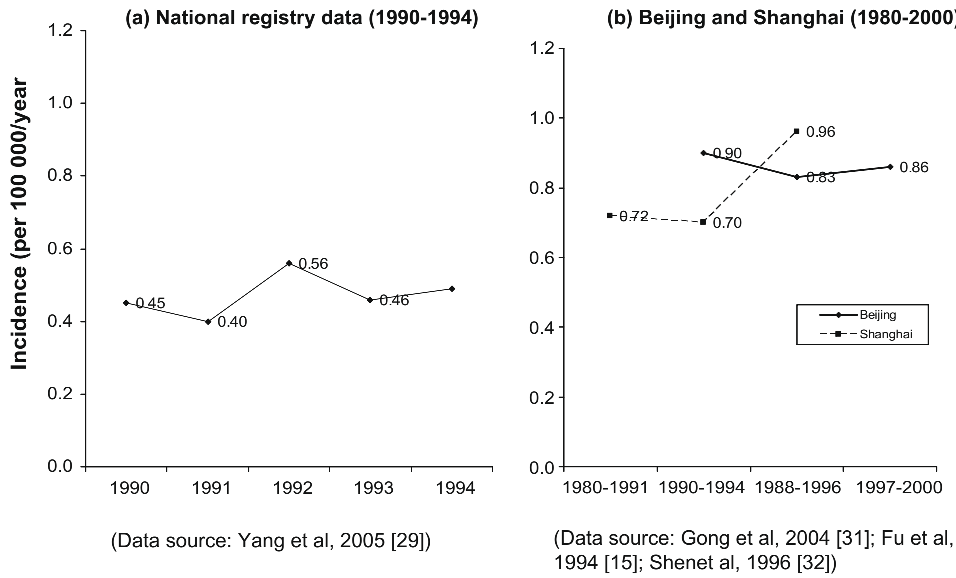


Figure 6 Time trend in the incidence rate (per 100,000/year) of Type 1 diabetes among children <15 years in Mainland China (Data source: Yang et al., 2005 [29]) (Data source: Gong et al., 2004 [31]; Fu et al., 1994 [15]; Shen et al., 1996 [32]).

Beijing and Shanghai: Fig. 6b shows the trend in the incidence of T1D in Beijing and Shanghai. The age-adjusted incidence (/per 100,000) was 0.83 in 1988—1996 and 0.86 in 1997—2000, respectively [31]. In Shanghai, the ascertainment-corrected incidence was 0.72 during 1980—1991 [15]. Another survey among children aged 0—14 years in urban Shanghai during 1989—1993 shows that the average crude annual incidence rate was 0.83 and the ascertainment-corrected incidence was 0.96 [32].

Type 2 diabetes in Hong Kong

A 1994—96 survey shows that the overall age-standardized prevalence of T2D was 9.5% in men and 10.2% in women aged 25—74 years in 1996 [33]. The prevalence was higher in men than in women before the age of 40 years, but thereafter, the prevalence became higher in women (Fig. 4a) [33]. Over a 5-year period between 1991 and 1996, the prevalence increased from 9.0% to 9.5% (a 6% increase) in men and 6.3% to 10.2% (a 62% increase) in women, respectively [33,34]. Note that we did not find any more recent representative data from Hong Kong.

Type 2 diabetes in Taiwan

Overall, published data from Taiwan did not show a clear increase in the prevalence of T2D in recent years, which may be due partially to the differences in the study samples including places where the samples were selected and the study participants' ages as well as in the T2D diagnostic criteria used. Nevertheless, the data suggest that the prevalence is higher than in mainland China. A recent study based on a 2001 representative survey of 8988 adults aged 40 years or older shows that the prevalence was 8.5% [35]. An earlier 1996 survey shows that the overall prevalence among adults aged 25—74 years old was 9.2% (10.4% in men vs. 8.1% in women) [36], compared to 5.8% indicated by a 1985 survey, i.e., increased by 59% [36,37]. The prevalence of IGT was 15.5% (15.0% in men and 15.9% in women) [38]. The available data consistently show that the prevalence of T2D and IGT increased with age in both genders, eg, the 1996 survey shows that T2D prevalence increased from 1.2% (1.3% in men and 1.1% in women) in those aged 20—29 years to 25.8% (28.2% in men and 23.1% in women) in those 60—69 years of age [36]. Women with IFG had a 1.6-fold higher risk for undiagnosed T2D compared to men (42% vs. 30%) [39]. A high proportion (75% for men and 86% for women) of combined IGT and undiagnosed T2D was found in subjects with IFG [39].

Impact of diabetes on risk of CVD

Among the studies that have examined the influence of diabetes on CVD, the Chinese Multi-provincial Cohort Study (CMCS) is one of the strongest. It assessed the 10-year risk of different types of CVD in relation to metabolic syndrome and IFG and diabetes. The CMCS study was a nationwide, multicenter, prospective cohort study of CVD conducted

Table 3 Hazard ratios (HRs) and 95% confidence interval (95% CI) of cardiovascular diseases (CVD) by impaired fasting glucose (IFG) and Type 2 diabetes (T2D), and estimated population-attributable risk (PAR).*

	CVD (CHD+Stroke)		CHD		Ischemic stroke	
	HR (95% CI)	PAR (%)	HR (95% CI)	PAR (%)	HR (95% CI)	PAR (%)
IFG	1.29 (1.10—1.51)	2.1	1.42 (1.06—1.89)	3.0	1.39 (1.12—1.73)	2.8
T2D	1.66 (1.33—2.09)	3.3	1.81 (1.20—2.71)	4.0	2.06 (1.54—2.76)	5.2

HR: hazard ratio; 95% CI: 95% confidence interval; CVD: cardiovascular disease; CHD: coronary heart disease; IFG: impaired fasting glucose; T2D: Type 2 diabetes; PAR: population-attributable risk. (Data source of HRs: Liu et al., Am Heart J 2007) [7].

* Normal fasting glucose was treated as the reference. We calculated PAR based on the HRs and prevalence of IFG (7.6%) and T2D (5.2%) according to a most recent nationwide survey (Gu et al., 2003) [10]. Note that in this study, T2D and IFG were classified using the ADA 1997 criteria and as a result, the prevalence might have been underestimated in the Chinese population.

during 1992—2003, and included 30,378 subjects aged 35—64 years selected from 11 provinces in Mainland China [5]. IFG and diabetes were found to be associated with a higher risk of incident CHD, ischemic stroke, and total CVD but not with hemorrhagic stroke, compared with normal fasting glucose (Table 3). Compared to those with a normal fasting glucose, subjects with IFG were 1.3 times more likely to develop CVD, while those with diabetes had a 1.7-fold higher risk of developing CVD.

Based on these estimated risks and the overall T2D prevalence of 5.2% in the year of 2001 [10], we estimated the PAR, indicating that 3.3% of CVD cases in Mainland China are attributable to T2D, and IFG accounted for 2.1% of CVD cases. T2D accounted for 4% of CHD and 5.2% of ischemic stroke. IFG accounted for 3% of CHD and 2.8% of ischemic stroke.

Discussion

The epidemic of T2D

The prevalence of T2D in China has been rising steadily during the past two decades and is projected to continue to increase [9,10,33,40]. A number of recent nationwide surveys in Mainland China provide good evidence of the increase in T2D. For example, a 2000—01 nationally representative survey shows that the age-standardized prevalence of T2D was 5.2% among Chinese adults aged 35—74 years, higher in urban (7.8%) than in rural areas (5.1%) [10]. In economically more developed areas such as Beijing and Shanghai, the prevalence is much higher than in other parts of the country [25,41].

Although major concerns, when one compares data across time are differences in the age distribution of the study populations, age-standardizations and in diagnostic criteria for diabetes, in general, the available data in China indicate a rising trend in the prevalence of T2D. The nationwide increase in the prevalence of T2D and the between-region difference in the prevalence are likely due to changes in people's lifestyles, an increase in obesity, and related between-region differences. Lifestyles in Chinese populations, especially in big cities have changed markedly with a shift from traditional (e.g., high-fiber diet and more physical activity) to sedentary lifestyles along with a high-fat and low-fiber diet [6]. Meanwhile, obesity has been increasing in China. The 1992 and 2002 China National Nutrition and Health Surveys show that the prevalence of obesity and overweight have increased in both men and women in all age groups and in urban and rural areas [4]. These all could have contributed to the increase in T2D [16,42].

The available data show that the prevalence of diabetes in Hong Kong appears to be comparable to that in Taiwan, but is much higher than in Mainland China. Chinese populations in Hong Kong and Taiwan generally live in an urbanized environment with a modern lifestyle [16]. Urbanization is associated with changes in a number of lifestyle factors, such as physical inactivity, unhealthy diet, and obesity, which are the key risk factors for T2D. On the other hand, there is evidence suggesting a catch-up trend in the prevalence of diabetes in Mainland China. By using the 1985 WHO diagnosis criteria, a recent review suggested a 33% increase in risk of diabetes from 1985—1994 to 1995—2003 in Mainland China, but only 15% in Hong Kong and Taiwan combined [16].

It is noteworthy to point out that, because different diagnostic criteria were used in previous studies carried out over different periods of time, it would be difficult to make meaningful comparisons between these studies [26]. During the past two decades, several different diagnostic criteria for diabetes were used [10,24—26]. Some studies indicate that compared to the 1985 WHO criteria, the 1999 WHO criteria may overestimate the prevalence, while the 1997 ADA criteria may underestimate it [43,44]. For example, among Hong Kong Chinese adults aged 25—74, the 1996 T2D prevalence was 6.2%, 9.2%, and 9.8% based on the 1997 ADA, 1985 WHO and 1999 WHO criteria, respectively. The ADA criteria seem to underestimate both T2D prevalence and cardiovascular risk in this population [44]. Another study shows that among 5023 US Pima Indian adults, the prevalence of T2D based on the ADA criteria, 1985 WHO criteria, and 1999 WHO criteria was 12.5%, 14.6% , and 15.3%, respectively [43]. Since the recent studies in China used the ADA criteria, the estimated prevalence of T2D would be even higher if based on the WHO 1985 or 1999 criteria and the upward trend in the prevalence is likely to be more dramatic.

Obesity and sedentary lifestyles are two key risk factors for T2D [16,42]. Considering the steady increase in the prevalence in obesity and the shifts in lifestyles among both adults and children in China over the past two decades as shown in recent studies including ours [1,2,4,45,46], it is certain that T2D will increase in China in the years to come. For example, one of our recent studies [4] shows that based on nationally representative survey data collected in 1992 and 2002, the combined prevalence of overweight and obesity has increased from 14.6% to 21.8% based on the BMI cut points of 25; while according to the Chinese BMI cut points of 24, it rose from 20.0% to 29.9%. In some major cities such as Beijing, where approximately half of the adult population is overweight or obese, the prevalence has reached a level similar to that in many other industrialized countries [4]. The increase in the prevalence of overweight children is even more alarming [47]. One in every five children in Beijing is overweight or obese [48].

Our projection based on the assumption that the observed trend will continue indicates that by the year of 2010, the prevalence will reach 8.6% among Chinese adults aged 20—74 years, and it will reach 14.4% by 2025. However, we suspect that the situation is likely to be worse as the study we referred to might have underestimated the real situation by using the ADA 1997 diagnostic criteria. Thus the prevalence of obesity and T2D may increase at faster rates. The trend in the increase of T2D observed in China is consistent with that observed worldwide. It is estimated that the prevalence of T2D in adults aged ⩾20 years worldwide is 4.0% in 1995 and will rise to 5.4% by the year 2025 [9]. It is projected that there will be a 42% increase from 51 to 72 million in the developed countries and a 170% increase from 84 to 228 million in developing countries. China will be one of the countries with the largest populations with diabetes in 2025 [9].

Epidemic of T1D

T1D is one of the most serious chronic diseases for children worldwide. China has a very low overall incidence rate and has large geographic and ethnic variations [15,30]. There is no significant gender-difference, and the incidence is higher in older children [31]. T1D is also extremely rare in Hong Kong [33]. The trends estimated for continents showed statistically significant increases all over the world [13]. The average annual increase in the incidence from 103 centers worldwide during 1990—1999 was 2.8%, and it was slightly higher at 3.4% during 1995—1999 [13]. In contrast, available data indicate that the incidence of T1D in China is relatively stable [15,32]. It has been argued that the constantly increasing incidence of T1D worldwide over a short period could not be explained by shifts in genetic susceptibility alone [13]. Rapid growth and obesity in early childhood may increase the risk of T1D [49]. Environmental factors may have a stronger effect on genetically non-susceptible individuals than those genetically susceptible to getting T1D [50—52]. It is speculated that environmental factors such as infectious diseases, lifestyles, psychosocial factors including social circumstances and life events may be related to the rising incidence of childhood diabetes [13]. Continuous efforts are needed for monitoring incidence and for treatment in China.

Diabetes and CVD

The morbidity and mortality of CVD have been rising in China in the past decades. CVD has become the leading cause of death, which accounts for more than 40% of total mortality in China [5,53,54]. Diabetes is a well-established risk factor for CVD along with hypertension, smoking, and dyslipidemia [5,7]. The CMCS study followed 30,378 subjects from 11 provinces in China for 10 years, and found that subjects with IFG and diabetes were at higher risk (eg, by 29 to 106% in relative terms; HRs were between 1.29 and 2.06) of developing CHD, ischemic stroke, and total CVD compared to those who had normal fasting glucose [5]. Our crude estimates of the population attributable risk (PAR) indicate that 3.3% of CVD cases in Mainland China may be attributable to T2D; with 4.0% of CHD and 5.2% of ischemic stroke cases. These estimations were based on the nationwide T2D prevalence reported in the InterASIA study, which used the ADA 1997 diagnostic criteria and thus likely has underestimated the prevalence of T2D and PAR.

Several large US-based prospective cohort studies have examined the effect of T2D on risk for CVD. In the Nurses' Health Study, 117,629 female nurses aged 30-55 years without CVD at baseline were followed for 20 years [55]. At baseline, 1,508 women had diagnosed T2D; and during the follow-up, 5,894 women developed T2D. Compared to women who remained free of diabetes, in women who developed T2D during follow-up, the multivariate-adjusted risk ratios (RRs) for myocardial infarction (MI) were 3.17 (2.61—3.85) and 3.97 (3.35—4.71) for the period before- and after the diagnosis of T2D, respectively. Cardiovascular risk factors were adjusted for age [55]. Another large study of 347,978 US men aged 35—57 years (5163 men had diabetes and 342,815 were non-diabetic at baseline) compared the CVD morbidity and mortality rates between diabetic and non-diabetic men during the 12-years of follow-up [56]. Diabetic patients had a 200% to 400% greater risk of developing CVD and their CVD mortality was also much higher in every age stratum, by 240% to 330%, even after adjusting for other CVD related risk factors such as age, race, income, serum cholesterol level, blood pressure, and smoking [56].

We suspect that at the population level, the impact of T2D on CVD is likely to be worse in China due to the high rate of undiagnosed cases and low rate of treatment among T2D patients. While the prevalence of diabetes is rising in China, available data show that a large proportion of diabetic patients remain undiagnosed [10,24,25,27,57]. Among all T2D patients, the percentage of undiagnosed T2D is approximately 70% in Mainland China compared to about 50% in Hong Kong and Taiwan [16]. Furthermore, many of the diagnosed T2D patients in China are not provided or maintained on the needed treatment to have their blood glucose controlled at the desirable level. Thus, eventually these patients are likely to develop overt diabetes and various complications including CVD. No doubt China will face more challenges and greater demands to address the growing chronic disease problems including T2D and CVD. The increase in the prevalence of T2D and obesity, the higher prevalence of T2D in the elderly, and the aging of the population will overburden its current health care system.

In summary, the prevalence of T2D has been increasing steadily over the past two decades in China. Diabetes affects cardiovascular health in the general population and may lead to an enormous economic burden to the society as well. The higher prevalence of IGT/IFG than that of diabetes indicates a large proportion of the population may suffer from pre-diabetes and related health consequences. The pre-diabetes of IFG/IGT has been identified as a risk factor for overt diabetes and CVD [10,58]. China's current relatively high prevalence of IFG/IGT also indicates that the prevalence of T2D will continue to rise unless effective preventive measures are implemented. It is necessary to establish a nationwide diabetes surveillance system in China to promote early detection and treatment. It should be recognized as a national public health priority, which must cover both urban and rural areas, to improve detection, prevention and treatment of diabetes. The higher prevalence of T2D in some population groups such as urban residents and the elderly calls for more vigorous efforts to target these high-risk groups. Westernized lifestyles (e.g., high-energy/high-fat diet, more sedentary lifestyles) and urbanization are the main risk factors that fuel the T2D epidemic [4,59]. People should be encouraged to preserve the traditional lifestyles to maintain a healthy diet and adequate physical activity in daily life. The fact that obesity and T2D are increasing rapidly nationwide especially among young people indicates that lifestyle modification programmes starting at young ages are urgently needed. Effective, comprehensive programs should be developed, including efforts by central and local governments, health professionals, and society to increase people's awareness and empower them for the prevention and treatment of T2D.

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References

[1] Du S, Lu B, Zhai F, Popkin BM. A new stage of the nutrition transition in China. Public Health Nutr 2002;5:169—74.

[2] Popkin BM, Horton S, Kim S, Mahal A, Shuigao J. Trends in diet, nutritional status, and diet-related noncommunicable diseases in China and India: the economic costs of the nutrition transition. Nutr Rev 2001;59:379—90.

[3] Wang Y, Monteiro C, Popkin BM. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. Am J Clin Nutr 2002;75:971—7.

[4] Wang Y, Mi J, Shan XY, Wang QJ, Ge KY. Is China facing an obesity epidemic and the consequences? The trends in obesity and chronic disease in China. Int J Obes (Lond) 2007;31:177—88.

[5] Liu J, Grundy SM, Wang W, et al. Ten-year risk of cardiovascular incidence related to diabetes, prediabetes, and the metabolic syndrome. Am Heart J 2007;153:552—8.

[6] Jia WP, Xiang KS, Chen L, Lu JX, Wu YM. Epidemiological study on obesity and its comorbidities in urban Chinese older than 20 years of age in Shanghai, China. Obes Rev 2002;3:157—65.

[7] Liu L. Cardiovascular diseases in China. Biochem Cell Biol 2007;85:157—63.

[8] Gu D, Gupta A, Muntner P, et al. Prevalence of cardiovascular disease risk factor clustering among the adult population of China: results from the International Collaborative Study of Cardiovascular Disease in Asia (InterAsia). Circulation 2005;112:658—65.

[9] King H, Aubert RE, Herman WH. Global burden of diabetes, 1995—2025: prevalence, numerical estimates, and projections. Diabetes Care 1998;21:1414—31.

[10] Gu D, Reynolds K, Duan X, et al. Prevalence of diabetes and impaired fasting glucose in the Chinese adult population: International Collaborative Study of Cardiovascular Disease in Asia (InterASIA). Diabetologia 2003;46:1190—8.

[11] Donnelly R, Wang B, Qu X. Type 2 diabetes in China: partnerships in education and research to evaluate new antidiabetic treatments. Br J Clin Pharmacol 2006;61: 702—5.

[12] Boutayeb A, Boutayeb S. The burden of non communicable diseases in developing countries. Int J Equity Health 2005;4:2.

[13] DIAMOND Project Group. Incidence and trends of childhood Type 1 diabetes worldwide 1990—1999. Diabet Med 2006;23:857—66.

[14] Karvonen M, Tuomilehto J, Libman I, LaPorte R. A review of the recent epidemiological data on the worldwide incidence of type 1 (insulin-dependent) diabetes mellitus. World Health Organization DIAMOND Project Group. Diabetologia 1993;36:883—92.

[15] Fu H, Shen SX, Chen ZW, et al. Shanghai, China, has the lowest confirmed incidence of childhood diabetes in the world. Diabetes Care 1994;17:1206—8.

[16] Wong KC, Wang Z. Prevalence of type 2 diabetes mellitus of Chinese populations in Mainland China, Hong Kong, and Taiwan. Diabetes Res Clin Pract 2006;73:126—34.

[17] Adeghate E. Diabetes mellitus — multifactorial in aetiology and global in prevalence. Arch Physiol Biochem 2001;109:197—9.

[18] Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes Care 1997;20:1183—97.

[19] World Health Organization, definition, diagnosis and classification of diabetes mellitus and its complications. Report of a WHO consultation. Part 1. Diagnosis and classification of diabetes mellitus. Geneva, Department of Noncommunicable Disease Surveillance; 1999.

[20] World Health Organization. WHO Expert Committee on diabetes mellitus. Technical Report Series 646, Geneva: WHO; 1980.

[21] World Health Organization. Technical Report Series, Geneva: WHO. No 727; 1985.

[22] Genuth S, Alberti KG, Bennett P, et al. Follow-up report on the diagnosis of diabetes mellitus. Diabetes Care 2003;26:3160—7.

[23] International Classification of Diseases: Ninth Version (ICD-9). <http://www.cdc.gov/nchs/icd9.htm>.

[24] Pan XR, Yang WY, Li GW, Liu J. Prevalence of diabetes and its risk factors in China, 1994. National Diabetes Prevention and Control Cooperative Group. Diabetes Care 1997; 20:1664—9.

[25] Wang K, Li T, Xiang H. Study on the epidemiological characteristics of diabetes mellitus and IGT in China. Zhonghua Liu Xing Bing Xue Za Zhi 1998;19:282—5.

[26] Zhong XL. Diabetes mellitus survey in China. Chin Med J (Engl) 1982;95:423—30.

[27] Yang Z. A survey of diabetes prevalence in the middle-aged and elderly Chinese from 12 areas of China. Chin J Endocrinol Metab 2002;18:280—4.

[28] Pan X, Yang W, Liu J. Prevalence of diabetes and its risk factors in China 1994. National Diabetes Prevention and Control Cooperative Group. Zhonghua Nei Ke Za Zhi 1997;36:384—9.

[29] Yang Z, Long X, Shen J, et al. Epidemics of type 1 diabetes in China. Pediatr Diabetes 2005;6:122—8.

[30] Yang Z, Wang K, Li T, et al. Childhood diabetes in China. Enormous variation by place and ethnic group. Diabetes Care 1998;21:525—9.

[31] Gong CX, Zhu C, Yan C, et al. Survey of type 1 diabetes incidence in children from 1997 to 2000 in Beijing area. Zhonghua Er Ke Za Zhi 2004;42:113—6.

[32] Shen SX, Wang HB, Chen ZW, et al. The incidence of insulin-dependent diabetes mellitus in urban districts of Shanghai (1989—1993). J Pediatr Endocrinol Metab 1996; 9:469—73.

[33] Lam TH, Liu LJ, Janus ED, Lam KS, Hedley AJ. Fibrinogen, other cardiovascular risk factors and diabetes mellitus in Hong Kong: a community with high prevalence of Type 2 diabetes mellitus and impaired glucose tolerance. Diabet Med 2000;17:798—806.

[34] Cockram CS, Woo J, Lau E, et al. The prevalence of diabetes mellitus and impaired glucose tolerance among Hong Kong Chinese adults of working age. Diabetes Res Clin Pract 1993;21:67—73.

[35] Chang HY, Chiou CJ, Lin MC, Lin SH, Tai TY. A population study of the self-care behaviors and their associated factors of diabetes in Taiwan: results from the 2001 National Health Interview Survey in Taiwan. Prev Med 2005;40:344—8.

[36] Lu FH, Yang YC, Wu JS, Wu CH, Chang CJ. A population-based study of the prevalence and associated factors of diabetes mellitus in southern Taiwan. Diabet Med 1998;15:564—72.

[37] Tai TY, Chuang LM, Chen CJ, Lin BJ. Link between hypertension and diabetes mellitus epidemiological study of Chinese adults in Taiwan. Diabetes Care 1991;14:1013—20.

[38] Chang C, Lu F, Yang YC, et al. Epidemiologic study of type 2 diabetes in Taiwan. Diabetes Res Clin Pract 2000; 50:S49—59.

[39] Pan WH, Yeh WT, Hwu CM, Ho LT. Undiagnosed diabetes mellitus in Taiwanese subjects with impaired fasting glycemia: impact of female sex, central obesity, and short stature. Chin J Physiol 2001;44:44—51.

[40] Pan WH, Yeh WT, Chang HY, Hwu CM, Ho LT. Prevalence and awareness of diabetes and mean fasting glucose by age, sex, and region: results from the nutrition and health survey in Taiwan, 1993—1996. Diabet Med 2003;20:182—5.

[41] Shi HL, Fang JC, Zhu XX. Prevalence of diabetes mellitus and associated risk factors in an adult urban population in Shanghai. Diabetes Metab 1998;24:539—42.

[42] Zhou BF. Effect of body mass index on all-cause mortality and incidence of cardiovascular diseases—report for meta-analysis of prospective studies open optimal cut-off points of body mass index in Chinese adults. Biomed Environ Sci 2002;15:245—52.

[43] Gabir MM, Hanson RL, Dabelea D, et al. The 1997 American Diabetes Association and 1999 World Health Organization criteria for hyperglycemia in the diagnosis and prediction of diabetes. Diabetes Care 2000;23:1108—12.
[44] Janus ED, Watt NM, Lam KS, et al. The prevalence of diabetes, association with cardiovascular risk factors and implications of diagnostic criteria (ADA 1997 and WHO 1998) in a 1996 community-based population study in Hong Kong Chinese. Hong Kong Cardiovascular Risk Factor Steering Committee. American Diabetes Association. Diabet Med 2000;17:741—5.
[45] Ji CY, Sun JL. Analyses of the epidemiological status of overweight and obesity in Chinese students and the prevalence changes in recent 15 years. Beijing Da Xue Xue Bao 2004;36:194—7.
[46] Ji CY. Report on childhood obesity in China (4) prevalence and trends of overweight and obesity in Chinese urban school-age children and adolescents, 1985—2000. Biomed Environ Sci 2007;20:1—10.
[47] Ji CY, Sun JL, Chen TJ. Dynamic analysis on the prevalence of obesity and overweight school-age children and adolescents in recent 15 years in China. Zhonghua Liu Xing Bing Xue Za Zhi 2004;25:103—8.
[48] Mi J, Cheng H, Hou DQ, Duan JL, Teng HH, Wang YF. Prevalence of overweight and obesity among children and adolescents in Beijing in 2004. Zhonghua Liu Xing Bing Xue Za Zhi 2006;27:469—74.
[49] Hypponen E, Virtanen SM, Kenward MG, Knip M, Akerblom HK. Obesity, increased linear growth, and risk of type 1 diabetes in children. Diabetes Care 2000;23:1755—60.
[50] Kaila B, Taback SP. The effect of day care exposure on the risk of developing type 1 diabetes: a meta-analysis of case-control studies. Diabetes Care 2001;24:1353—8.
[51] Kaila B, Dean HJ, Schroeder M, Taback SP. HLA, day care attendance, and socio-economic status in young patients with Type 1 diabetes. Diabet Med 2003;20:777—9.
[52] Gillespie KM, Bain SC, Barnett AH, et al. The rising incidence of childhood type 1 diabetes and reduced contribution of high-risk HLA haplotypes. Lancet 2004;364:1699—700.
[53] Truelsen T, Mahonen M, Tolonen H, Asplund K, Bonita R, Vanuzzo D. Trends in stroke and coronary heart disease in the WHO MONICA Project. Stroke 2003;34:1346—52.
[54] He J, Gu D, Wu X, et al. Major causes of death among men and women in China. N Engl J Med 2005;353:1124—34.
[55] Hu FB, Stampfer MJ, Haffner SM, Solomon CG, Willett WC, Manson JE. Elevated risk of cardiovascular disease prior to clinical diagnosis of type 2 diabetes. Diabetes Care 2002;25:1129—34.
[56] Stamler J, Vaccaro O, Neaton JD, Wentworth D. Diabetes, other risk factors, and 12-yr cardiovascular mortality for men screened in the multiple risk factor intervention trial. Diabetes Care 1993;16:434—44.
[57] Steinman RA, Birshtein BK. Treatment and awareness of type 2 diabetes in Beijing, China, compared to New York. Diabetes Educ 2007;33:282—90.
[58] de Vegt F, Dekker JM, Jager A, et al. Relation of impaired fasting and postload glucose with incident type 2 diabetes in a Dutch population: The Hoorn study. JAMA 2001;285:2109—13.
[59] Silink M. Childhood diabetes: a global perspective. Horm Res 2002;57:1—5.
[60] Li LM, Rao KQ, Kong LZ, et al. A description on the Chinese national nutrition and health survey in 2002. Zhonghua Liu Xing Bing Xue Za Zhi 2005;26:478—84.
[61] The incidence of diabetes mellitus in 40,000 population in Beijing with discussion on difference criteria of its diagnosis. Zhonghua Nei Ke Za Zhi 1982;21:85—7.
[62] Pang XH, Jiao SF, Huang L, Duan JL, Ren ZY, Liu ZJ. Nutrition and health status of the Beijing residents. Zhonghua Yu Fang Yi Xue Za Zhi 2005;39:269—72.
[63] Diabetes mellitus survey in Shanghai. Chin Med J (Engl) 1980;93:663—72.
[64] Li R, Lu W, Jia WP, et al. Cross-sectional investigation of prevalence of type 2 diabetes in Shanghai. Zhonghua Yi Xue Za Zhi 2006;86:1675—80.
[65] Wu KW, Wei TH. The prevalence rate of diabetes mellitus in a group aged 40—69 in Taipei City, 1985. Taiwan Yi Xue Hui Za Zhi 1986;85:1069—77.