

The rising tide of diabetes mellitus in a Chinese population: a population-based household survey on 121,895 persons

Martin C. S. Wong · Michael C. M. Leung ·
Caroline S. H. Tsang · S. V. Lo · Sian M. Griffiths

Received: 27 June 2011/Revised: 14 April 2012/Accepted: 16 April 2012/Published online: 3 May 2012
© Swiss School of Public Health 2012

Abstract

Objectives We studied the prevalence of self-reported diabetes mellitus in selected years from 2001 to 2008, and evaluated the factors associated with diabetes.

Methods From territory-wide household interviews in a Chinese population in the years 2001, 2002, 2005 and 2008, we evaluated the trend of self-reported diabetes with respect to age, sex and household income. Binary logistic regression analyses were conducted to study the independent factors associated with diabetes.

Results From 121,895 respondents in the household surveys, 103,367 were adults aged 15 years or older. Among male respondents, the age- and sex-adjusted prevalence of diabetes in 2001, 2002, 2005 and 2008 was 2.80, 2.87, 3.32 and 4.66 %, respectively; while among female respondents the respective prevalence was 3.25, 3.37, 3.77 and 4.31 %. In all the years, the prevalence escalated with age and increased sharply among the poor. From binary logistic regression analyses, advanced age and low monthly household income were significantly associated with self-report of diabetes.

Conclusions This study showed a rising trend of diabetes mellitus in a large Chinese population and found a strong association between population demography and diabetes.

Keywords Diabetes mellitus · Prevalence · Age · Gender · Socioeconomic status

Introduction

Diabetes mellitus imposes a substantial burden to the healthcare system and is recognized as a worldwide health crisis (Feinglos and Bethel 2007). There is an estimated 20.8 million people affected in the US in 2002, and the costs incurred amount to \$132 billion (Hogan et al. 2003). The World Health Organization estimates for the number of persons affected by diabetes were 171 millions in 2000 and 266 millions in 2030 (Wild et al. 2004), while the International Diabetes Federation estimates were 246 millions in 2007 and 380 millions in 2025 (International Diabetes Federation 2006). A significant increase in the number of people affected by diabetes is expected in the next few decades.

Varying prevalence rates of diabetes were reported in different countries. According to the National Health and Nutrition Examination Survey (NHANES), the prevalence of diabetes was 9.3 % among adults aged 20 years or older (Cowie et al. 2006). In the UK, the prevalence of type 2 diabetes was 3.2 and 4.7 % in Europoid men and women, respectively; while among Asians living in the same city of Coventry, the respective figures were 12.4 and 11.2 % (Simmons et al. 1991). It was found that the higher prevalence of diabetes in Asians than the Europoids were not attributable to obesity, implying that a lesser extent of excess of adiposity is required in Asians than in Europoids for the development of diabetes. Ethnicity therefore plays an important role in precipitating diabetes.

The International Collaborative Study of Cardiovascular Disease in Asia conducted in 2000–2001 found that the

M. C. S. Wong (✉) · M. C. M. Leung · S. M. Griffiths
School of Public Health and Primary Care, Faculty of Medicine,
Chinese University of Hong Kong, 4/F, School of Public Health
and Primary Care, Prince of Wales Hospital, Shatin, NT,
Hong Kong SAR, China
e-mail: wong_martin@cuhk.edu.hk

C. S. H. Tsang · S. V. Lo
Food and Health Bureau, The Government of the Hong Kong
Special Administrative Region, Hong Kong SAR, China

prevalence of self-reported diabetes was 1.3 % (Gu et al. 2003), and the age-standardized true prevalence of diabetes was higher in subjects living in northern compared to southern China (7.4 vs. 5.4 %, $p < 0.001$). In addition, those living in urban areas had higher prevalence than residents in rural areas (7.8 vs. 5.1 %, $p < 0.001$). Hong Kong is one of the most rapidly developing economies in Asia (Leung et al. 2005); its westernization, urbanization and cultural mix due to population mobility could contribute to a higher diabetes prevalence. Previous studies in Hong Kong showed that the prevalence ranged from 2 % in people aged <35 years to 20 % in those 65 years or older (Chan et al. 2009; Department of Health, The Government of Hong Kong Special Administrative Region 2012; Janus et al. 2000). The incidence of diabetes is increasing in Hong Kong, but more than half of those affected remain undiagnosed (Janus et al. 2000; Wong and Wang 2006). By 2025, it was estimated that 12.8 % of the Hong Kong population, or 1 million people, will suffer from diabetes (Diabetes Hong Kong 2008). However, there is a scarcity of large-scale studies which adopted a representative sampling methodology in recent years to inform public health policy.

The objectives of this study are to evaluate the prevalence of self-reported diabetes by territory-wide household surveys representative of the whole Hong Kong population, and examined the factors independently associated with diabetes.

Methods

Sampling frame and methodology

The detailed methodology has been described elsewhere (Leung et al. 2005; Census and Statistics Department 2010). The Census and Statistics Department, the Government of the Hong Kong Special Administrative Region commissioned Thematic Household Surveys (THS) on health-related issues in 2001, 2002, 2005 and 2008. A major objective of these surveys was to collect information on the health status of the Hong Kong population. The household surveys included all the land-based population of Hong Kong who were residents in non-institutional settings. They excluded hotel transients, persons residing on board vessels and foreign live-in domestic helpers. The survey field works in 2001, 2002, 2005 and 2008 were conducted in the time periods Jan 2001–May 2001; May 2002–July 2002; Nov 2005–Mar 2006 and Feb 2008–May 2008, respectively.

Based on a sample of quarters selected from all permanent quarters and quarters in segments which are for residential and partially residential purposes in Hong Kong,

these household surveys were conducted in accordance with a scientifically designed sampling scheme. The present study adopted a stratified random sampling methodology. The sampling units included permanent quarters in built-up regions and segments in non-built-up regions. The Register of Quarters consists of computerized records of all addresses of permanent quarters in built-up regions. These regions included urban areas, new towns and other major developed areas. Unique address was used to identify each unit of quarters with information like street name, building name, floor and flat number. The Register of Segments consists of records of segments in non-built-up areas, identified by relatively permanent and delineated landmarks like footpaths and rivers. The household surveys covered approximately 96 % of the total Hong Kong resident population. The approximate response rates for these household surveys were 75 %, consistently across all four survey rounds.

Interviewers and survey instrument

The design of the surveys obtained input from the Hong Kong Government. A Research firms commissioned by the Census and Statistics Department of Hong Kong trained all interviewers using a standardized method for face-to-face interviews. The survey question related to the outcome variable was “Do you have any disease that require long-term follow-up by doctors?” in 2001; the wordings of the corresponding questions in the other two rounds are slightly different; specifically, “Have you ever been diagnosed by a doctor to suffer from the following chronic/long-term diseases?” in 2002; and “Do you have the following chronic or long-term disease(s) diagnosed by a medical doctor, which require long-term follow-up?” in 2005. The corresponding question in 2008 was “Have you ever been told by a western medicine practitioner that you had the following chronic health conditions?” If the respondents gave a positive reply, they were further asked whether they had diabetes. The interviewers also recorded demographic information such as age, sex and monthly household income.

Outcome variables and statistical analysis

STATA version 8.0 was used for all data analysis. The primary outcome variable was rates of self-reported diabetes mellitus, defined as a positive reply to the above-mentioned questions. We studied the proportion of survey respondents having diabetes in 2001, 2002, 2005 and 2008, and compared the trends according to age, sex and income as a proxy measure of socioeconomic status. We used age- and sex-adjusted prevalence rates taking into account changes in population demography across the years. A

Table 1 Respondent characteristics ($N = 121,895$) in the household face-to-face interviews conducted in Hong Kong, China by stratified random sampling of living quarters in the whole territory in the years 2001, 2002, 2005 and 2008

	All		2001 ($n = 33,609$)		2002 ($n = 29,561$)		2005 ($n = 29,802$)		2008 ($n = 28,923$)	
	No.	%	No.	%	No.	%	No.	%	No.	%
Age (years)										
<15	18,528	15.2	5,683	16.9	4,951	16.7	4,179	14.0	3,715	12.8
15–24	16,834	13.8	4,808	14.3	3,945	13.3	4,138	13.9	3,943	13.6
25–34	17,751	14.6	5,418	16.1	4,290	14.5	4,174	14.0	3,869	13.4
35–44	22,206	18.2	6,472	19.3	5,703	19.3	5,286	17.7	4,745	16.4
45–54	20,033	16.4	4,856	14.4	4,506	15.2	5,346	17.9	5,325	18.4
55–64	11,179	9.2	2,493	7.4	2,463	8.3	2,939	9.9	3,284	11.4
65–74	9,139	7.5	2,522	7.5	2,225	7.5	2,165	7.3	2,227	7.7
≥75	6,225	5.1	1,357	4.0	1,478	5.0	1,575	5.3	1,815	6.3
Sex										
Male	60,064	49.8	16,484	49.0	14,663	49.6	14,728	49.4	14,189	49.1
Female	61,831	50.2	17,125	51.0	14,898	50.4	15,074	50.6	14,734	50.9
Monthly household income (HK dollars) ^a										
≥50,000	12,452	10.4	4,128	12.3	2,512	9.0	2,357	8.1	3,455	11.9
25,000–49,999	32,748	27.4	9,624	28.6	6,823	24.6	8,415	28.9	7,886	27.3
10,000–24,999	50,648	42.4	13,695	40.7	11,927	43.0	13,153	45.2	11,873	41.1
≤9,999	23,578	19.7	6,162	18.3	6,502	23.4	5,205	17.9	5,709	19.7

^a There are 2,469 observations with missing information of household income. It shows the demographic characteristics of all survey respondents

binary logistic regression model was conducted with self-reported diabetes as the outcome variable. Age (referent 0–39 years), sex (referent female) and monthly household income (referent \geq \$50,000) were used as covariates in the regression analysis. To explore any heterogeneity in association between increasing age- and self-reported diabetes among men versus women, we stratified all subjects according to sex and similar regression analyses were run separately for male and female groups. P values ≤ 0.05 were regarded as statistically significant.

Results

A total of 33,609, 29,561, 29,802 and 28,923 interviews were successfully conducted in the years 2001, 2002, 2005 and 2008, respectively. Among them, 103,367 were adults aged 15 years or above. Their average age was 38.2 years. Table 1 illustrated the distribution of age, sex and monthly household income of the respondents. In general, the respondents were older and had higher monthly household income in surveys conducted in more recent years (both $p < 0.001$) (Table 1). The characteristics of respondents were different which implied a change in population structure since the sample methodology was similar across the years. The age-adjusted prevalence of diabetes among male adults was 2.80, 2.87, 3.32 and 4.66 % in years 2001,

2002, 2005 and 2008, respectively. Among female adults, the respective prevalence was 3.25, 3.37, 3.77 and 4.31 % (sex-specific logistic regression models, all $p < 0.001$) (Fig. 1; Tables 2, 3). The adjusted prevalence in both sex groups showed a drastic rise with increasing age. There was a progressive rising trend of self-reported diabetes across the years 2001–2008 in the age groups ≥ 75 years. From logistic regression analysis using year 2001 as a reference controlling for age, the relative rates of increase

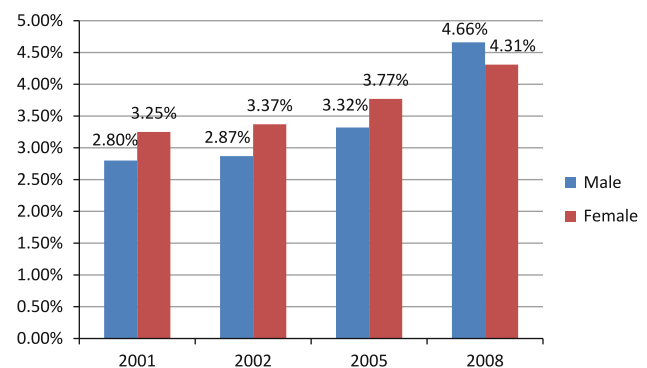


Fig. 1 The prevalence of self-reported diabetes among persons aged ≥ 15 years in selected years from 2001 to 2008 in the household face-to-face interviews conducted in Hong Kong, China in the years 2001, 2002, 2005 and 2008 by stratified random sampling of living quarters in the whole territory. The prevalence is age-adjusted across different years

Table 2 Prevalence of self-reported diabetes among male adults aged ≥ 15 years ($N = 50,427$) in the household face-to-face interviews conducted in Hong Kong, China by stratified random sampling of living quarters in the territory in the years 2001, 2002, 2005 and 2008

Age (years)	2001		2002		2005		2008	
	%	SD	%	SD	%	SD	%	SD
15–24	0.13	3.57	0.05	2.32	0.09	3.02	0.09	3.02
25–34	0.12	3.45	0.14	3.77	0.26	5.10	0.06	2.51
35–44	0.79	8.87	1.02	10.05	1.11	10.47	1.36	11.59
45–54	2.34	15.19	2.31	15.03	2.79	16.46	3.85	19.24
55–64	6.84	25.39	6.87	25.30	6.20	24.12	8.73	28.22
65–74	11.18	31.51	10.45	30.59	11.26	31.61	17.56	38.05
≥ 75	10.90	31.16	13.24	33.89	13.93	34.63	16.12	36.77
Adults ≥ 15	2.80	16.35	2.87	16.69	3.32	17.90	4.66	21.08

The table shows the age-specific prevalence of self-reported diabetes across different years

SD standard deviation

Table 3 Prevalence of self-reported diabetes among female adults aged ≥ 15 years ($N = 52,895$) in the household face-to-face interviews conducted in Hong Kong, China by stratified random sampling of living quarters in the territory in the years 2001, 2002, 2005 and 2008

Age (years)	2001		2002		2005		2008	
	%	SD	%	SD	%	SD	%	SD
15–24	0.04	2.04	0.12	3.44	0.17	4.07	0.11	3.27
25–34	0.14	3.69	0.43	6.57	0.15	3.93	0.27	5.18
35–44	0.63	7.92	0.66	8.08	1.08	10.33	0.58	7.57
45–54	2.69	16.24	2.13	14.45	2.16	14.54	2.41	15.35
55–64	9.63	29.52	7.95	27.05	7.00	25.52	8.31	27.60
65–74	13.24	33.90	14.02	34.72	14.66	35.37	15.15	35.85
≥ 75	12.07	32.57	14.05	34.75	15.91	36.58	20.44	40.33
Adults ≥ 15	3.25	17.44	3.37	18.04	3.77	19.04	4.31	20.32

The table shows the age-specific prevalence of self-reported diabetes across different years

in prevalence among male adults (27.8 and 47.9 % in 2005 and 2008, respectively) were lower than those among female adults (31.8 and 69.3 %, respectively) ($p < 0.001$). The age- and sex-adjusted (“population adjusted” thereafter) prevalence progressively increased across the years in the two lowest income groups among male and female respondents. There was however no definite observed differences in prevalence trends between male and female respondents (Table 4).

When the independent association between patient demographics and rates of diabetes was analyzed by multivariate regression models, older age [adjusted odds ratio (AOR) 32.2, 95% CI 20.6–50.4, $p < 0.001$ for 40–65 years; AOR 120.1, 95% CI 76.6–188.3, $p < 0.001$ for older than

65 years) and lower income (AOR 2.19, 95% CI 1.66–2.88, $p < 0.001$ for monthly household income \leq HK\$9,999 or US\$1,287) were significantly associated with diabetes (Table 5). The respondents’ sex has no association with the prevalence of diabetes. There exists a trend that the association between advanced age and diabetes was more marked among male respondents (AOR 45.4, 95% CI 22.5–91.8 for age 40–65 years; AOR 141.1 95% CI 69.5–286.5 for age older than 65 years; both $p < 0.001$) when compared with female respondents (AOR 23.5, 95% CI 13.1–42.0 for age 40–65 years; AOR 105.5, 95% CI 58.9–188.8 for age older than 65 years; both $p < 0.001$) (Table 5). There exists no multicollinearity in the regression analysis. The coefficient of determination (R^2), defined as the proportion of variability in a dataset that is accounted for by the statistical model (Steel and Torrie 1960), was 0.198. It indicated that the independent variables entered into this regression analysis accounted for 19.8 % of the variability of diabetes prevalence.

Discussion

Major findings

Our study found that the prevalence of self-reported diabetes increased by approximately 50 % from 2001 to 2008, and the rise was especially drastic among female residents (69.3 %) when compared with male respondents (47.9 %). Besides, we did not detect any significant differences in prevalence between men and women when respondents were divided into different age and income groups, but male respondents had steeper relationship between advanced age and diabetes prevalence than females. Thirdly, those with low household income were twofold more likely to report diabetes when compared with those having the highest income.

Relationship with literature and explanations of findings

The prevalence of diabetes in China was 5.5 % in the years 2000–2001 (Gu et al. 2003), a figure twice of that reported 10 years ago (Pan et al. 1997). Janus et al. (2000) conducted a population-based study in Hong Kong involving 2,900 Chinese persons aged 25–74 years in 1995–1996 using a 75 g oral glucose tolerance test, and found a prevalence rate of 6.2 % (95% CI 5.3–7.1 %) using the American Diabetes Association criteria (1997). However, the prevalence figures were 9.2 (95% CI 8.1–10.3 %) and 9.8 % (95% CI 8.7–10.9 %), respectively, using the WHO (1995) and WHO (1998) criteria. Our study used self-reported information and it was therefore difficult to

Table 4 Adjusted prevalence of self-reported diabetes by monthly household income and sex for all respondents in the household face-to-face interviews conducted in Hong Kong, China by stratified random sampling of living quarters in the whole territory in the years 2001, 2002, 2005 and 2008

Monthly household income (HK dollars)	Year	Adjusted prevalence ^a (% , SD)			
		Male (<i>n</i> = 58,854)		Female (<i>n</i> = 60,572)	
		%	SD	%	SD
≥50,000	2001	1.37	11.47	1.46	11.75
	2002	1.98	13.95	1.11	10.48
	2005	1.26	11.17	2.67	16.12
	2008	1.80	13.30	1.68	12.85
25,000–49,999	2001	1.72	12.91	2.21	14.43
	2002	1.75	13.10	2.06	14.21
	2005	2.35	15.14	2.04	14.13
	2008	2.86	16.66	2.09	14.29
10,000–24,999	2001	1.87	13.89	2.41	15.14
	2002	1.90	13.37	2.50	15.48
	2005	2.16	14.55	2.87	16.68
	2008	3.25	17.73	3.40	18.13
≤9,999	2001	4.83	18.76	5.1	19.92
	2002	4.60	19.28	5.11	20.50
	2005	6.50	24.66	6.37	24.43
	2008	8.97	28.57	8.28	27.56

^a Adjusted prevalence refers to population adjustment by monthly household income

compare with findings from other studies. However, the rising trend of diabetes across the years from 2001 to 2008 in this study was in general compatible with results from other surveys. Increasing prevalence rates have previously been reported in the US (Cowie et al. 2006; Harris et al. 1998), Australia (Dunstan et al. 2002), Denmark (Drivsholm et al. 2001), the Indian city of Chennai (Ramachandran et al. 1997; Mohan et al. 2006) and the Indian Ocean island of Mauritius (Soderberg et al. 2005).

The escalating prevalence of diabetes from the current findings could be due to increasing incidence over time. Some of the reasons include population ageing and rapid urbanization, which is associated with lifestyle changes including unhealthy diet, physical inactivity, obesity and sedentary habits (Gu et al. 2003). On the other hand, it might be attributed to a better primary healthcare system in Hong Kong which detected diseases early among the younger individuals with risk factors, fundamentally due to heightened awareness of earlier diagnosis and more effective community-based health educational programs. Nevertheless, reduced mortality has also been suggested as a contributing factor to the rising prevalence, and recent opinions are mixed as to what factors are the most influential (Colagiuri et al. 2005; Wareham and Forouhk 2005; Green et al. 2005; Gale 2003). Demographic changes are not sufficient to explain the rising rates, and hence there is a need for future studies capturing age-specific incidence data for the same population likely to have experienced the same risk factor changes over distinct time periods (Wareham and Forouhk 2005).

The current literature involving larger-scale population surveys do not demonstrate a consistent difference between male and female in the prevalence of diabetes, and a large-scale study in China by Gu et al. (2003) showed a statistically similar age-standardized prevalence of self-reported diabetes between the two genders. In addition, it is of interest to note that with increasing age, the prevalence of diabetes in males increased more sharply than females. This observation is yet to be addressed by future studies.

Our study clearly showed that the lowest income group suffered from much higher risk of diabetes. A population-based survey conducted in the UK studying socioeconomic status and its relationship with diabetes (Connolly et al. 2000) showed that the prevalence of type 2 diabetes was around 30 % higher in residents living in regions with the worst quintile of deprivation scores when compared with residents in the richest area. Similar conclusions were echoed by studies based on a diabetes register in Scotland (Evans et al. 2000) and general practices in Spain (Larranaga et al. 2005). However, the influence of socioeconomic deprivation on diabetes seemed to run in opposite direction in the developing nations. A study in India highlighted that those in the high income group were twofold more likely to have diabetes than the lower income group residents (American Diabetes Association 2010), while another study in the Mainland China showed the similar higher risk among the rich. It has been postulated that in developed countries, those living in districts of deprivation have poorer access to health information and healthcare services, thus consuming lower cost, yet less healthy, energy-dense diets (Feinglos and Bethel 2007). In developing

Table 5 Factors associated with self-reported diabetes among all respondents in 2008 in the household face-to-face interviews conducted in Hong Kong, China in the year 2008 by stratified random sampling of living quarters in the whole territory

	Total no.	Diabetes reported	%	Adjusted odds ratios	95% CI	<i>P</i> value
All respondents (<i>N</i> = 28,923; <i>R</i> ² = 0.198)						
Age (years)						
0–39	13,741	20	0.15	1	Referent	
40–65	11,479	527	4.59	32.21	20.59–50.37	<0.001
>65	3,703	636	17.18	120.08	76.6–188.26	<0.001
Sex						
Female	14,734	580	3.94	1	Referent	
Male	14,189	603	4.25	1.10	0.97–1.24	NS
Monthly household income (HK dollars)						
≥50,000	3,455	64	1.85	1	Referent	
25,000–49,999	7,886	206	2.61	1.39	1.04–1.86	<0.05
10,000–24,999	11,873	414	3.49	1.58	1.2–2.07	<0.001
≤9,999	5,709	499	8.74	2.19	1.66–2.88	<0.001
Male respondents (<i>n</i> = 14,189; <i>r</i> ² = 0.191)						
Age (years)						
0–39	6,720	8	0.12	1	Referent	
40–65	5,678	296	5.21	45.43	22.49–91.79	<0.001
>65	1,791	299	16.69	141.08	69.47–286.48	<0.001
Monthly household income (HK dollars)						
≥50,000	1,686	33	1.96	1	Referent	
25,000–49,999	3,888	119	3.06	1.59	1.07–2.36	<0.05
10,000–24,999	5,890	203	3.45	1.51	1.03–2.21	<0.05
≤9,999	2,725	248	9.10	2.28	1.55–3.35	<0.001
Female respondents (<i>n</i> = 14,734; <i>r</i> ² = 0.208)						
Age (years)						
0–39	7,021	12	0.17	1	Referent	
40–65	5,801	231	3.98	23.49	13.13–42.02	<0.001
>65	1,912	337	17.63	105.45	58.91–188.77	<0.001
Monthly household income						
≥50,000	1,769	31	1.75	1	Referent	
25,000–49,999	3,998	87	2.18	1.20	0.79–1.83	NS
10,000–24,999	5,983	211	3.53	1.66	1.13–2.45	<0.05
≤9,999	2,984	251	8.41	2.14	1.44–3.16	<0.001

Self-reported diabetes was the outcome of interest with age, sex and monthly household income as independent variables

countries, poorer residents are more likely to be employed in manual work with limited access to labor-saving facilities. This increase in physical activity, together with the higher consumption of fruit and vegetables among the poorer may explain their lower prevalence of diabetes in developing nations (Feinglos and Bethel 2007).

Strengths and limitations

This study included the data of a total of more than 121,000 respondents collected in surveys and the standardized methods used with proper interviewer training were

identical across different time periods. The population-based random sampling method facilitated generalizability of our findings, and the statistical adjustment made to the prevalence figures minimized the effect of demographic changes in different years. However, several limitations should be mentioned. First, we relied on self-reported information to ascertain the prevalence of diabetes, and recent studies in China suggested three out of four diabetes patients were undiagnosed (diagnosed diabetes 1.3 % vs. undiagnosed diabetes 4.2 %) (Gu et al. 2003). Thus far there has been no information in any sub-populations on the validity of self-reported diabetes when compared with

standardized methodology. In addition, there were other variables which could influence the prevalence of diabetes not taken into account in our study, including lifestyle factors, body mass index and family history of diabetes. Also, this survey adopted a study design by stratified random sampling. The regression analyses explained approximately 20 % of the variability of diabetes prevalence, and more work is needed to explore its relationship with other risk factors in this large Chinese population.

Implication to clinical practice and policy-making

Our findings have important public health implications. The development of the micro- and macro-vascular diabetes complications leads to a huge burden to the society (American Diabetes Association 2010). The rising prevalence of diabetes detected in this study signals a need for more extensive community-based educational programs especially targeted towards the higher risk group. In addition, the promotion of clinical guidelines in primary care is a crucial step towards clinic-based diabetes screening for the early detection of diabetes and impaired glucose tolerance. In Hong Kong, a recent reference framework for diabetes care in primary care setting has been developed and promulgated in clinical practice (Hong Kong Reference Framework 2011). Future research will need to evaluate the impact of primary care initiatives to combat the rising trend of diabetes by engaging different stakeholders of the healthcare system (Hong Kong Reference Framework 2011).

In summary, this study found an increasing prevalence of diabetes from 2001 to 2008, and we have reasons to anticipate that this trend will continue to rise. These findings cautioned the need to formulate territory-wide strategies to improve prevention, detection and treatment of diabetes by more intensive, concerted efforts of the multidisciplinary primary care teams.

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standards The surveys comply with the current laws of the country in which they were performed.

References

- American Diabetes Association (2010) Standards of medical care in diabetes-2010. *Diabetes Care* 33 (Suppl 1):S11–S61
- Census and Statistics Department (2010) The Government of the Hong Kong special administrative region. http://www.censtatd.gov.hk/hong_kong_statistics/social_topics_studies/index.jsp. Accessed 30 Aug 2010
- Chan JC, Malik V, Jia W, Kadowaki T, Yajnik CS, Yoon KH et al (2009) Diabetes in Asia: epidemiology, risk factors, and pathophysiology. *JAMA* 301:2129–2140
- Colagiuri S, Borch-Johnsen K, Glumer C, Vistisen D (2005) There really is an epidemic of type 2 diabetes. *Diabetologia* 48:1459–1463
- Connolly V, Unwin N, Sherriff P, Bilous R, Kelly W (2000) Diabetes prevalence and socioeconomic status: a population based study showing increased prevalence of type 2 diabetes mellitus in deprived areas. *J Epidemiol Community Health* 54:173–177
- Cowie CC, Rust KF, Byrd-Holt DD, Eberhardt MS, Flegal KM, Engelgau MM et al (2006) Prevalence of diabetes and impaired fasting glucose in adults in the U.S. population: national health and nutrition examination survey 1999–2002. *Diabetes Care* 29:1263–1268
- Department of Health, The Government of Hong Kong Special Administrative Region (2012) Heart health survey 2004/2005. http://www.chp.gov.hk/files/pdf/Heart_Health_Survey_en_2007_1109.pdf. Accessed 31 March 2012
- Diabetes Hong Kong (2008) Response to the “Your Health, Your Life”. Healthcare Reform Consultation June 2008. <http://www.fhb.gov.hk/beStrong/files/organizations/O017.pdf>. Accessed 01 Oct 2011
- Drivsholm T, Ibsen H, Schroll M, Davidsen M, Borch-Johnsen K (2001) Increasing prevalence of diabetes and impaired glucose tolerance among 60-year-old Danes. *Diabet Med* 18:126–132
- Dunstan DW, Zimmet PZ, Welborn TA, de Courten MP, Cameron AJ, Sicree RA et al (2002) The rising prevalence of diabetes and impaired glucose tolerance: the Australian diabetes, obesity and lifestyle study. *Diabetes Care* 25:829–834
- Evans JM, Newton RW, Ruta DA, MacDonald TM, Morris AD (2000) Socio-economic status, obesity and prevalence of Type I and Type 2 diabetes mellitus. *Diabet Med* 17:478–480
- Feinglos MN, Bethel MA (eds) (2007) Contemporary endocrinology: type 2 diabetes mellitus. An evidence-based approach to practical management. Humana Press, Totowa, NJ, USA. ISBN: 978-1-58829-794-5
- Gale EA (2003) Is there really an epidemic of type 2 diabetes? *Lancet* 362:503–504
- Green A, Stovring H, Andersen M, Beck-Nielsen H (2005) The epidemic of type 2 diabetes is a statistical artifact. *Diabetologia* 48:1456–1458
- Gu D, Reynolds K, Duan X, Xin X, Chen J, Wu X, Mo J, Whelton PK, He J, for the InterASIA collaborative Group et al (2003) Prevalence of diabetes and impaired fasting glucose in the Chinese adult population: international collaborative study of cardiovascular disease in Asia (InterASIA). *Diabetologia* 46:1190–1198
- Harris M, Flegal K, Cowie C, Eberhardt M, Goldstein D, Little R et al (1998) Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in US adults. The third national health and nutrition examination 1988–1994. *Diabetes Care* 21:518–524
- Hogan P, Dall T, Nikolov P (2003) American diabetes association. Economic costs of diabetes in the US in 2002. *Diabetes Care* 26:917–932
- Hong Kong Reference Framework for Diabetes Care for Adults in Primary Care Settings (2011) http://www.fhb.gov.hk/en/press_and_publications/otherinfo/101231_reference_framework/index.html. Accessed 11 Jan 2011
- International Diabetes Federation (2006) Diabetes atlas, 3rd edn. International Diabetes Federation, Brussels
- Janus ED, Wat NM, Lam KS, Cockram CS, Siu ST, Liu LJ et al (2000) 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. *Diabet Med* 17:741–745
- Larranaga I, Arteagoitia JM, Rodriguez JL, Gonzalez F, Esnaola S, Pinies JA (2005) Socio-economic inequalities in the prevalence

- of Type 2 diabetes, cardiovascular risk factors and chronic diabetic complications in the Basque Country, Spain. *Diabet Med* 22:1047–1053
- Leung GM, Wong IOL, Chan WS, Choi S, Lo SV et al (2005) Health care financing study group. The ecology of health care in Hong Kong. *Soc Sci Med* 61:577–590
- Mohan V, Deepa M, Deepa R, Shanthirani CS, Farooq S, Ganesan A et al (2006) Secular trends in the prevalence of diabetes and impaired glucose tolerance in urban South India—the Chennai urban rural epidemiology study (CURES-17). *Diabetologia* 49: 1175–1178
- Pan X-R, Yang W-Y, Li G-W, Liu J (1997) The national diabetes prevention and control cooperative group. Prevalence of diabetes and its risk factors in China. *Diabetes Care* 20:1664–1669
- Ramachandran A, Snehalatha C, Latha E, Vijay V, Viswanathan M (1997) Rising prevalence of NIDDM in an urban population in India. *Diabetologia* 40:232–237
- Simmons D, Williams DR, Powell MJ (1991) The coventry diabetes study: prevalence of diabetes and impaired glucose tolerance in Europoids and Asians. *Q J Med* 81:1021–1030
- Soderberg S, Zimmet P, Tuomilehto J, de Courten M, Dowse GK, Chitson P et al (2005) Increasing prevalence of Type 2 diabetes mellitus in all ethnic groups in Mauritius. *Diabet Med* 22:61–68
- Steel RGD, Torrie JH (1960) Principles and procedures of statistics. McGraw-Hill, New York, pp 187, 287
- Wareham NJ, Forouh NG (2005) Is there really an epidemic of diabetes? *Diabetologia* 48:1454–1455
- Wild S, Roglic G, Green A, Sicree R, King H (2004) Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care* 27:1047–1053
- Wong KC, Wang Z (2006) Prevalence of type 2 diabetes mellitus of Chinese populations in Mainland China, Hong Kong and Taiwan. *Diabetes Res Clin Pract* 73:126–134