ORIGINAL ARTICLE

Comparing the disease profiles of adult patients with type 2 diabetes mellitus attending four public health care facilities in Malaysia

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Abstract

Aim: We examined disease profiles of patients with type 2 diabetes mellitus (T2D) at four different public health facilities in Malaysia to determine which site would be the most suitable for early and intensive diabetes care against diabetes-related complications.

Methods: This study analysed 57,780 T2D patients in the Adult Diabetes Control and Management registry database in the year 2009. The four public health facilities were hospital with specialists (HS), hospital without specialists (HNS), health clinics with family medicine specialists (CS) and health clinic without doctors (CND). Descriptive analyses were used to examine age, duration of diseases, intervals from the onset of diabetes to co-morbidities (hypertension and dyslipidaemia) and complication of T2D patients at the four public health facilities.

Results: Patients were significantly older in HS. Patients with T2D at HS had significantly longer duration of diabetes, hypertension and dyslipidaemia. Health clinics, both the CS and the CND, were seeing T2D patients with shorter duration of macrovascular and microvascular complications.

Conclusion: Public health clinics in this country managed T2D patients who were younger and at the early stage of diabetes, hypertension, dyslipidaemia and complications. Thus, primary care physicians are best positioned to provide early and intensive diabetes care for this group of T2D patients to prevent the development of diabetes-related complications.

Introduction

The prevalence of diabetes mellitus in Malaysia is rising. It was less than 10% in the last century, increased to about 15% in the first decade of the 21st century and further increased up to more than 20% in the recent National Health Morbidity Survey 2011.[1,2] This translates to a staggering number of 3 million patients with diabetes mellitus. This epidemic is not specific to this country; in fact it is widely reported worldwide, and about one-third of a billion of world population is now living with diabetes.[3] The International Diabetes Federation (IDF) has classified diabetes mellitus as an "international disaster" and the United Nation Summit in 2011 passed the political declaration to curb diabetes and other non-communicable diseases.

The cost of care for patients with diabetes mellitus is ever increasing, more after the onset of complications and hospital care.[4,5] It has been predicted that the global cost of diabetes would increase 100% to USD 490 billion in 2030 from 2010.[6] Studies have shown that treatment of diabetes and its co-morbidities, namely hypertension and dyslipidaemia, to the recommended targets were effective in reducing the incidence of morbidity and mortality related to diabetes complications.[7] Early and intensive treatment was recommended in patients with a shorter duration of type 2 diabetes mellitus (T2D) and without advanced complications.[8] Past evidence has indicated that the risk of complications was not only reduced but also long-term benefits (glycaemic memory or legacy effect) were possible if T2D controlled to targets early.[9,10] Therefore, optimal control of T2D is best achieved at the early stage of the disease.

This study was set out to compare the disease profiles of T2D patients at four different public health facilities in Malaysia based on the duration of diabetes and its related co-morbidities and complications. The results

of this study would help to determine which public health care facility has the most suitable profiles of patients for early intensive treatment of T2D and preventive care against diabetes-related complications.

Methods

Data used in this paper were obtained from the Adult Diabetes Control and Management (ADCM) registry. It registered a total of 70,889 diabetes patients by December 31, 2009.[11] Only adult patients aged ≥18 years were registered. All patients were informed of the on-going registry and given the opportunity to opt out. The participation in ADCM was not mandatory for patients and health centres. All participating patients were registered on a paper form or via online standard case record form. Registrations at each health care facility were done for all newly diagnosed diabetes patients and for those patients who were transferred from other facilities. This transfer of care was signified by the transfer of the big green medical record from one facility to another facility (see below for further description). Thus, duplication of patient in the registry was avoided or minimised. Completed registration and database in ADCM was real time and was updated at least annually. The central database was analysed by using Stata (StataCorp LP, College Station, Texas, USA) version 9 and PASW 19.0 (SPSS, Chicago, IL). Further description on the work flow of this registry and its descriptive report on demography, clinical characteristics, process measures, treatment modalities and complication rates had been published elsewhere.[11,12]

The four public health facilities were hospital with specialists (HS), hospital without specialists (HNS), health clinics with FMS and doctors (CS) and health clinic without doctors (CND). The public health care in Malaysia is organised by the Ministry of Health, structured into public health and hospital care. The health clinics are generally well linked to the secondary and tertiary public hospitals with a seamless referral system. Diabetes care at these public health clinics is managed by family medicine specialists (FMSs), medical officers (MOs), physician assistants and often supported by specialised nurses and dietitians/nutritionists. In hospitals, this is provided by specialists in internal medicine or endocrinology/diabetology, medical officers and by specialised nurses. Every patient who is diagnosed with diabetes mellitus will receive a green booklet (kept by patients), which comes in pair with a bigger green medical record book (kept at the health clinics) that tracks all information pertaining to all medical care provided. Diabetic patients generally visit their physicians several times per year. The patients in health clinics are generally managed by physician assistants and MO (non-specialist primary care physicians), but once they become uncontrolled or have complications, they will be transferred to the care of FMS, who may co-manage with the hospital specialist. Referrals to specialists at secondary or tertiary hospitals are done for patients with complicated diseases in need of treatments and expertise that are not available in health clinics. Further details about ADCM and Malaysian health care system for diabetic patients have been described elsewhere.[12-15]

Definitions of study participants

The definition of T2D was confirmed when patient's case record fulfilled the following criteria: (i) either documented diagnosis of diabetes mellitus according to the World Health Organization criteria or (ii) whose current treatment consisted of lifestyle modification and those on oral anti-hyperglycaemic agents (AHAs) or insulin. Hypertension was defined as the systolic blood pressure of ≥130 mm Hg or the diastolic blood pressure of ≥80 mm Hg on each of two successive readings obtained by the clinic physician. Dyslipidaemia was defining as an increase or decrease in concentration of one or more plasma or serum lipids – a low-density lipoprotein-cholesterol (LDL-C) >2.6 mmol/L, triglyceride (TG) >1.7 mmol/L and high-density lipoprotein-cholesterol (HDL-C) <1.1 mmol/L.

Macrovascular complications consist of stroke and ischaemic heart disease (IHD). Microvascular complications include retinopathy, nephropathy and foot problems. These complications were retrieved from patient records. Diagnoses of these complications were made or confirmed by the attending physician at the clinic based on the clinical symptoms, laboratory results, radiological evidence and treatment history at the clinic and other hospitals. Nephropathy was diagnosed as persistent presence (≥2 occasions with at least 3 months apart) of any of the following: microalbuminuria, proteinuria, serum creatinine >150 mmol/L or estimated glomerular filtration rate <60 mL/min (was calculated using the Cockroft-Gault formula). Foot problems include foot deformity, current ulcer, amputation, peripheral neuropathy or peripheral vascular disease.

Statistical analysis

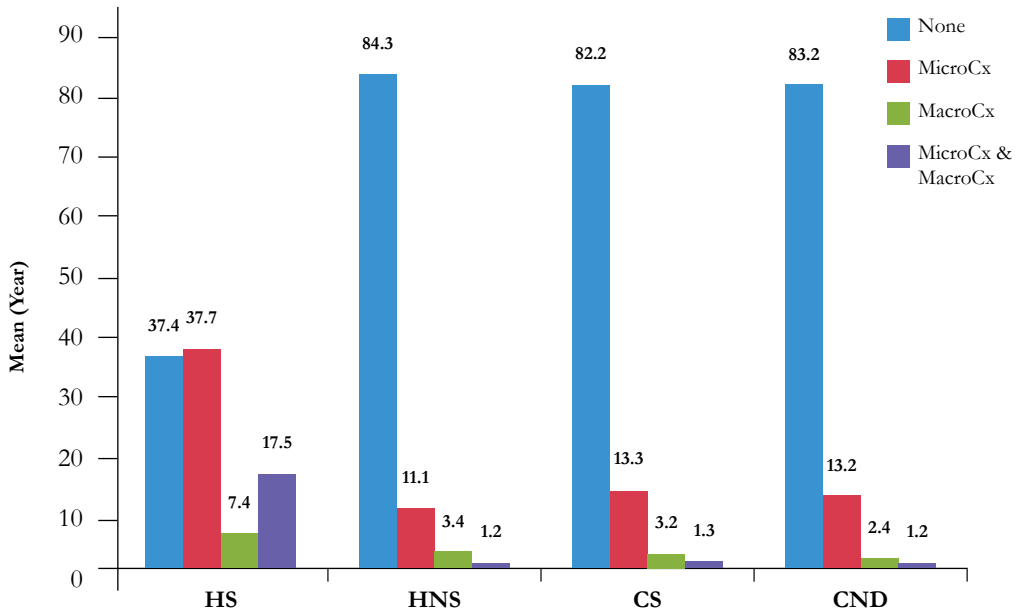
Descriptive analyses were used for age, duration of diseases, diabetes to co-morbidities and complication intervals of T2D patients. Age was calculated from the birth date; durations of diabetes, hypertension, dyslipidaemia and complications were calculated from the date of diagnosis; intervals were calculated by taking the calendar year in which the disease or complication was diagnosed subtracting from the year in which diabetes was diagnosed. Positive intervals mean onset after diabetes and negative means disease/complication reported precede diabetes. Comparisons of mean levels were performed using the one-way ANOVA. A P value of <0.05 was considered to be significant at two tails. We analysed and summed up the mean duration for T2D, hypertension and dyslipidaemia (DCoD) in each patient for each facility in order to show the characteristics of advanced diseases and burden of the co-morbid diseases. We also added on to the DCoD the mean duration of all diabetic complications in each patient for each facility (DCoCxD) so as to portray more vividly the characteristics of advanced diseases and burden of the co-morbid diseases and diabetes-related complications.

Results

Of the 57780 T2D patients with complete data for this study, about 4.5% (2606/57780) were managed at hospitals either with specialists or without specialists. Of these, 59% were women. Malay comprised 61.9%, Chinese 19% and Indian 18%. HNS, CS and CND were managing majority of the T2D patients without complications (Figure 1).

The mean age and duration of diabetes in years for patients at HS were significantly greater and longer. T2D patients at HS were having significantly longer duration of hypertension and dyslipidaemia. Health clinics, both the CS and CND, were generally seeing T2D patients with shorter duration of macrovascular and microvascular complications, but not foot deformity and amputation that showed no statistical difference among the four facilities (Table 1). Hospitals, especially the HS, were managing T2D patients with long-standing co-morbidities and diabetes-related complications (Figure 2).

Figure 1. Proportion of patient with T2D with no complication, microvascular and macrovascular complications in each public health care facility



CND, health clinic without doctor; CS, health clinics with family medicine specialist; HNS, hospital without specialist; HS, hospital with specialist; MicroCx, microvascular complication, MacroCx, macrovascular complication.

Table 1. A comparison of patient's age, duration of diseases and diabetes to diseases intervals in the four public health facilities in Malaysia, n= 57780

In year	Total, n (%*)	Type of public health care facility, n (%*)				*F* Statistic	*P* value
		HS	HNS	CS	CND		
n (%#)	57780 (100)	1572 (2.7)	1034 (1.8)	43100 (74.6)	12074 (20.9)	58.97	<0.0001
Age, mean (SD)	58.2 (11.07)	61.7 (12.83)	58.9 (10.76)	58.1 (11.04)	58.0 (10.87)		
Duration of diseases							
T2D	57462 (99.4)	1567 (99.7)	1029 (99.5)	42856 (99.4)	12010 (99.5)	605.66	<0.0001
Mean (SD)	5.9 (5.56)	11.1 (8.68)	6.4 (5.72)	5.9 (5.53)	4.9 (4.62)		
Hypertension	40622 (70.3)	1238 (78.8)	753 (72.8)	30317 (70.3)	8314 (68.9)	302.11	<0.0001
Mean (SD)	5.9 (5.84)	10.4 (8.64)	7.1 (6.71)	5.9 (5.73)	5.2 (5.31)		
Dyslipidaemia	26763 (46.3)	1056 (67.2)	483 (46.7)	20025 (46.5)	5199 (43.1)	317.97	<0.0001
Mean (SD)	2.9 (3.29)	5.5 (5.10)	2.8 (2.93)	3.0 (3.32)	2.2 (2.29)		
Diabetic Cx	10789 (18.7)	984 (62.6)	162 (15.7)	7626 (17.7)	2017 (16.7)	335.58	<0.0001
Mean (SD)	3.2 (4.95)	7.6 (8.88)	4.0 (5.83)	2.9 (4.20)	2.0 (3.47)		
MacroCx	2817 (4.9)	392 (24.9)	47 (4.5)	1940 (4.5)	438 (3.6)	57.81	<0.0001
Mean (SD)	4.8 (5.33)	7.8 (6.47)	7.4 (6.77)	4.4 (4.96)	3.8 (4.60)		
Stroke	624 (1.1)	124 (7.9)	10 (1.0)	402 (0.9)	88 (0.7)	11.97	<0.0001
Mean (SD)	5.1 (5.22)	7.4 (5.82)	3.4 (5.06)	4.7 (4.97)	3.7 (4.50)		
IHD	2301 (4.0)	290 (18.4)	37 (3.6)	1600 (3.7)	374 (3.1)	49.74	<0.0001
Mean (SD)	4.5 (5.02)	7.4 (5.93)	8.5 (6.82)	4.1 (4.73)	3.5 (4.26)		
MicroCx	8964 (15.5)	867 (55.2)	127 (12.3)	6244 (14.5)	1726 (14.3)	222.56	<0.0001
Mean (SD)	2.3 (3.64)	5.1 (6.28)	2.4 (3.48)	2.2 (3.21)	1.4 (2.48)		
Retinopathy	3113 (5.4)	205 (13.0)	90 (8.7)	2355 (5.5)	463 (3.8)	43.52	<0.0001
Mean (SD)	1.9 (2.58)	3.9 (4.30)	1.6 (1.98)	1.9 (2.41)	1.6 (2.12)		
Nephropathy	5183 (9.0)	679 (43.2)	29 (2.8)	3647 (8.5)	828 (6.9)	115.80	<0.0001
Mean (SD)	1.9 (2.44)	3.3 (3.24)	2.8 (5.01)	1.8 (2.22)	1.1 (1.92)		
Neuropathy	1490 (2.6)	367 (23.3)	6 (0.6)	764 (1.8)	353 (2.9)	30.11	<0.0001
Mean (SD)	1.9 (2.68)	2.8 (3.22)	1.0 (1.10)	1.9 (2.58)	0.9 (1.86)		
PVD Duration	368 (0.6)	42 (2.7)	4 (0.4)	70 (0.2)	252 (2.1)	60.29	<0.0001
Mean (SD)	0.8 (2.00)	4.0 (3.97)	0.5 (1.00)	1.0 (1.43)	0.3 (0.89)		
Foot Deformity	155 (0.3)	2 (0.1)	2 (0.2)	101 (0.2)	50 (0.4)	0.07	0.975
Mean (SD)	1.1 (2.00)	1.00 (0)	1.50 (0.7)	1.0 (0.96)	1.1 (3.26)		
Foot Ulcer	419 (0.7)	21 (1.3)	10 (0.1)	277 (0.6)	111 (0.9)	7.13	<0.0001
Mean (SD)	1.3 (1.92)	2.0 (2.62)	3.1 (2.77)	1.4 (2.02)	0.8 (1.12)		
Amputation	265 (0.5)	26 (1.7)	9 (0.9)	176 (0.4)	54 (0.4)	2.18	0.091
Mean (SD)	3.1 (3.66)	4.1 (3.84)	2.9 (2.15)	3.3 (3.97)	2.1 (2.33)		

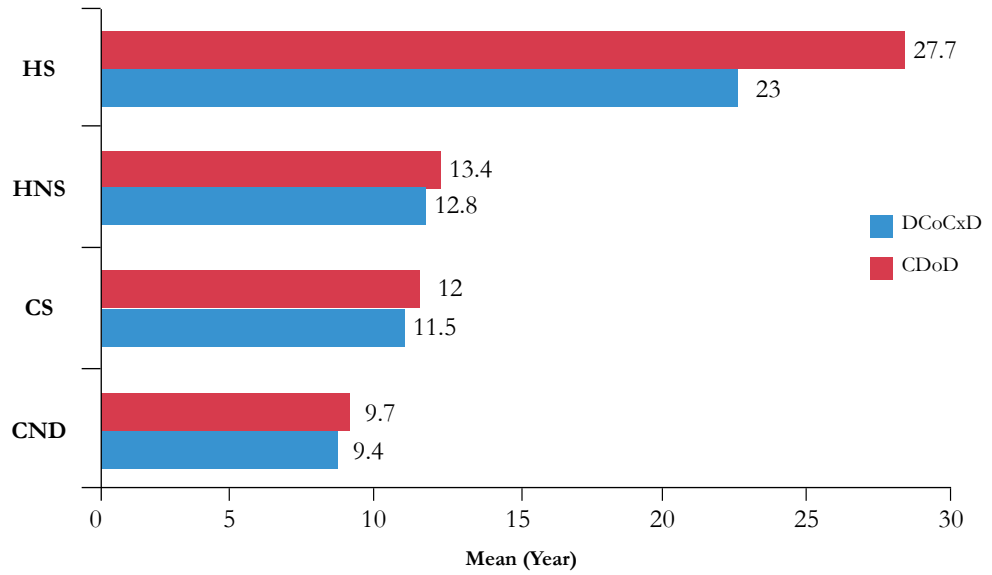
Table 1. A comparison of patient's age, duration of diseases and diabetes to diseases intervals in the four public health facilities in Malaysia, n= 57780 (cont'd)

Diabetes to co-morbidities and complication intervals							
Diabetes-Hpt	40583 (70.2)	1232 (78.4)	753 (72.8)	30286 (70.3)	8312 (68.8)	9.36	<0.0001
Mean (SD)	0.6 (7.51)	1.4 (10.10)	0.03 (9.18)	0.7 (7.44)	0.4 (7.16)		
Diabetes-Dyslip	26736 (40.3)	1051 (66.9)	483 (46.7)	20004 (46.4)	5198 (43.1)	49.10	<.0001
Mean (SD)	3.8 (6.84)	6.1 (8.98)	4.6 (7.77)	3.7 (6.82)	3.4 (6.22)		
Diabetes-Stroke	624 (1.1)	124 (7.9)	10 (1.0)	402 (0.9)	88 (0.7)	3.98	0.008
Mean (SD)	4.1 (8.68)	6.4 (8.84)	2.9 (8.63)	3.4 (8.01)	4.3 (10.73)		
Diabetes-IHD	2299 (4.0)	289 (18.4)	37 (3.6)	1599 (3.7)	374 (3.1)	18.94	<0.0001
Mean (SD)	3.9 (8.29)	6.7 (9.67)	-1.6 (8.01)	3.4 (7.67)	4.2 (9.07)		
Diabetes-Retino	3099 (5.4)	201 (12.8)	89 (8.6)	2347 (5.4)	462 (3.8)	32.55	<0.0001
Mean (SD)	7.3 (8.32)	12.1 (10.13)	5.7 (6.08)	7.3 (8.41)	5.4 (6.34)		
Diabetes-Nephro	5174 (9.0)	677 (43.1)	29 (2.8)	3640 (8.4)	828 (6.9)	72.26	<0.0001
Mean (SD)	6.8 (7.83)	10.8 (9.09)	5.2 (9.33)	6.3 (7.38)	5.7 (7.61)		
Diabetes-Neuro	1481 (2.6)	363 (23.1)	6 (0.6)	760 (1.8)	352 (2.9)	103.71	<0.0001
Mean (SD)	7.3 (8.22)	13.3 (10.02)	5.3 (4.27)	5.4 (6.81)	5.1 (5.60)		
Diabetes-PVD	367 (0.6)	41 (2.6)	4 (0.4)	70 (0.2)	252 (2.1)	39.57	<0.0001
Mean (SD)	6.5 (6.91)	16.1 (8.59)	7.0 (4.97)	5.9 (5.24)	5.1 (5.73)		
Diabetes-FootDe	155 (0.3)	2 (0.1)	2 (0.2)	101 (0.2)	50 (0.4)	8.51	<0.0001
Mean (SD)	5.5 (5.23)	22.0 (8.49)	5.5 (3.54)	5.7 (4.94)	4.4 (4.68)		
Diabetes-Foot Ulcer	417 (0.7)	20 (1.3)	10 (1.0)	276 (0.6)	111 (0.9)	8.63	<0.0001
Mean (SD)	7.1 (8.47)	15.3 (8.25)	11.0 (10.27)	6.9 (9.23)	5.6 (4.67)		
Diabetes-Amput	262 (0.5)	25 (1.6)	9 (0.9)	174 (0.4)	54 (0.4)	8.12	<0.0001
Mean (SD)	7.9 (8.75)	15.5 (10.54)	9.2 (6.63)	7.3 (8.09)	6.0 (8.60)		

*Column percentage; #Row percentage.

Amput, amputation; CND, health clinic without doctor; CS, health clinics with family medicine specialist; Cx, complication; Dyslip, dyslipidaemia; F, ANOVA F statistic; FootDe, foot deformity; Hpt, hypertension; HNS, hospital without specialist; HS, hospital with specialist; IHD, ischaemic heart disease,; MacroCx, macrovascular complication, MicroCx, microvascular complication; Nephro, nephropathy; Neuro, neuropathy, PVD, peripheral vascular disease, , Retino, retinopathy; T2D, type 2 diabetes mellitus.

Figure 2. A comparison of accumulative mean duration of type 2 diabetes, hypertension, dyslipidaemia and all diabetes-related complications within each public health care facility in Malaysia, n= 57780.



CND, health clinic without doctor; CS, health clinics with family medicine specialist;;DCoCxD, accumulative mean duration of diabetes + hypertension + dyslipidaemia + total diabetes complications; DCoD, accumulative mean duration of diabetes + hypertension + dyslipidaemia; HS, hospital with specialist; HNS, hospital without specialist.

Discussion

We noted that the public health clinics managed T2D patients who were younger, had shorter duration of diabetes and its related complications. On the other hand, both categories of the hospitals were managing older patients with longer duration of diabetes, co-morbidities and complications. This signifies that hospitals were seeing (T2D patients) who were older, and at higher risk. These patients were expected to have shorter life expectancy, extensive co-morbid conditions and with advanced microvascular or macrovascular complications.[16] However, vast differences were observed between the HS and both categories of the health clinics. HNS appeared to have slightly older group of T2D patients with more advanced MacroCx, and rather similar proportion of diabetes-related complications among its T2D patients, when compared to the health clinics. Being situated nearer to the community or in the rural areas, the HNS could have been the convenient option for in-patient medical care for T2D patients from the surrounding public health clinics. T2D patients at HNS who were having higher risk might have been referred to the HS. This probably explains the intermediate profiles of patients and diseases in HNS with the HS and health clinics at the other two ends.

Primary care clinics in many Asian[17,18] and Western countries[19,20] were managing older patients when compared to their hospital-based outpatient diabetes clinics. Perhaps early diabetes care was more successful at these health clinics, reducing the risk of complications leading to older patients being managed at their primary care clinics. It was also possible that sub-optimal diabetes care at our primary care clinics had resulted in high referrals of T2D patients with more co-morbidities and complications to hospitals. As a result, the public health clinics in Malaysia were caring for T2D patients who were younger and had shorter duration of diabetes, whereas those who had more complications were being managed at the HS. In view of the long-term benefits of early control in T2D and its related co-morbidities of hypertension and dyslipidaemia on the complications,[10,21] more health investment in diabetes care at primary care level will be worthwhile.

Glycaemic memory exerts deferred effects of an earlier glycaemic control on the later diabetic complications, independent of its recent glycaemic status.[22 23] The "glucose tetrad" of HbA1c, glycaemic variability, fasting and postprandial plasma glucose activate oxidative stress causing vascular complications through endothelial dysfunction and damage.[24-26] Low-density lipoprotein-cholesterol (LDL-C) oxidation and glycosylation, which are further aggravated by the presence of hyperglycaemia, contribute to the progression of atherosclerosis by promoting vascular smooth muscle cells migration and proliferation.[27] The presence of hypertension in patients with diabetes has another detrimental effect on the micro- and macrovasculature. These include impaired autoregulation in the microcirculation, the non-dipping of nocturnal blood pressure owing to autonomic dysfunction, increased pulse-wave velocity and ventricular-vascular mis-coupling from premature stiffening of the abdominal aorta by elastic fibres glycation.[28] Thus, it is believed that early control of diabetes, hypertension and dyslipidaemia, with medication or lifestyle modification, confers long-term beneficial effects on the cardiovascular outcomes.[21]

Being able to bring greatest benefits to T2D patients, primary care physicians are to optimise preventive care services, which comprise opportunistic screening for early diagnosis of pre-diabetes and diabetes as well as timely and regular screenings for diabetes-related complications. Screening for diabetes-related complications, controlling diabetes and cardiovascular risk factors with combination of multidrug regimens have been proven cost-effective in developing countries.[29,30] Therefore, intensive treatments and therapeutic interventions to achieve recommended treatment targets for glycaemia, hypertension, dyslipidaemia and many other risk factors should be improved. Notwithstanding the greater need for more intensive management, primary care physicians are to be cautioned when treating diabetes and its co-morbidities to the lowest control targets in older T2D patients who have more longstanding diseases and complications.[31,32] In view of the need for individualised care, multi-disciplinary teams approach should be considered in delivering an effective and efficient chronic disease management in T2D. More important is the patient-centred education and support such as diabetes self-management education, which are able to empower T2D patients to maintain adequate self-care and lead a quality life.[8,33-36] Nevertheless, we realise that effective prevention of diabetes should not be focused on health care facilities alone, but also involving other governmental agencies and non-governmental organisations. These include thoughtful town planning, vibrant national economy and

workplace policies that encourage employment with satisfactory income, healthy diet and physical activity.

The strengths of this study include the population-based cohort design, large sample size, detailed data on diabetes-related co-morbidities and complications. However, there are several limitations. Participation of health facilities was on a voluntary basis. They could represent those health facilities and physicians who were more interested in diabetes care and therefore not be reflective of diabetes care delivered by Malaysian physicians in general. However, for the comparisons made between the participating health facilities in this study, this characteristic would not be a source of bias.

Compared to public hospitals, public health clinics in this country managed T2D patients who were younger, at the early stages of diabetes, hypertension, dyslipidaemia and complications. Thus, health clinics have the most suitable T2D patients among the four public health care facilities to be providing intensive diabetes care. Primary care physicians must avoid clinical inertia in managing this group of patients. Supporting the public health clinics to achieve this would be of the highest priority in face of escalating epidemic of this disease in Malaysia.

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Ethics

This study has been approved by the Medical Research Ethics Committee (MREC) on December 2008. Protocol number from the National Medical Research Register: NMRR ID: 08-12-1167.

Conflict of interest

None to declare.

References

1. Institute for Public Health, National Institutes of Health. National Health Morbidity Survey III, 2006. Vol. II. Ministry of Health Malaysia, Putrajaya; 2008.
2. Gurpreet K, Jasvindar K, Nalachakravarthy O, et al. (Eds). National Health Morbidity Survey IV. Institute for Public Health, National Institutes of Health, Ministry of Health Malaysia, Kuala Lumpur. 2011.
3. Whiting DR, Guariguata L, Weil C, et al. IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract. 2011;94:311-21.
4. Khowaja LA, Khuwaja AK, Cosgrove P. Cost of diabetes care in out-patient clinics of Karachi, Pakistan. BMC Health Serv Res. 2007;7:189.
5. Currie CJ, Morgan CL, Dixon S, et al. The financial costs of hospital care for people with diabetes who have single and multiple macrovascular complications. Diabetes Res Clin Pract. 2005;67:144-51.
6. International Diabetes Federation. Diabetes Atlas, 4th ed; 2010.
7. American Diabetes Association. Standards of Medical Care in Diabetes—2012. Diabetes Care. 2012;35:S11-63.
8. George D. Early and intensive therapy for management of hyperglycemia and cardiovascular risk factors in patients with type 2 diabetes. Clin Ther. 2011;33:665-78.
9. Macisaac RJ, Jerums G. Intensive glucose control and cardiovascular outcomes in type 2 diabetes. Heart Lung Circ. 2011;20:647-54.
10. Bailey CJ, Day C. Glycaemic memory. The British Journal of Diabetes & Vascular Disease. 2008; 8: 242-7.

11. Mastura I, Chew BH, Lee PY, et al. Control and treatment profiles of 70,889 adult type 2 diabetes mellitus patients in Malaysia. International Journal of Collaborative Research on Internal Medicine & Public Health. 2011;3:98-113.

12. Mastura I, Zanariah H, Fatanah I, et al. An audit of diabetes control and management (ADCM). Med J Malaysia. 2008;63(suppl C):76-7.

13. Chew BH, Mastura I, Lee PY, et al. Determinants of uncontrolled dyslipidaemia among adult type 2 diabetes in Malaysia: The Malaysian Diabetes Registry 2009. Diabetes Res Clin Pract. 2012;96:339-47.

14. Yasin S, Chan CK, Reidpath DD, et al. Contextualizing chronicity: A perspective from Malaysia. Global Health. 2012;8:4.

15. Lee PY, Cheong AT, Zaiton A, et al. Does ethnicity contribute to the control of cardiovascular risk factors among patients with type 2 diabetes? Asia Pac J Public Health. 2013; 25(4): 316-325.

16. Hotta N, Nakamura J, Iwamoto Y, et al. Causes of death in Japanese diabetics: A questionnaire survey of 18,385 diabetics over a 10-year period. J Diabetes Investig. 2010;1:66-76.

17. Tai TY, Chuang LM, Tsai ST, et al. Treatment of type 2 diabetes mellitus in a primary care setting in Taiwan: comparison with secondary/tertiary care. J Formos Med Assoc. 2006;105(2):105-17.

18. Arai K, Hirao K, Matsuba I, et al. The status of glycemic control by general practitioners and specialists for diabetes in Japan: a cross-sectional survey of 15,652 patients with diabetes mellitus. Diabetes Res Clin Pract. 2009;83(3):397-401.

19. Ismail H, Wright J, Rhodes P, Scally A. Quality of care in diabetic patients attending routine primary care clinics compared with those attending GP specialist clinics. Diabet Med. 2006;23(8):851-6.

20. De Berardis G, Pellegrini F, Franciosi M, et al. Quality of care and outcomes in type 2 diabetic patients: a comparison between general practice and diabetes clinics. Diabetes Care. 2004;27(2):398-406.

21. Jermendy G. Vascular memory: can we broaden the concept of the metabolic memory? Cardiovasc Diabetol. 2012;11:44.

22. Holman RR, Paul SK, Bethel MA, et al. 10-year follow-up of intensive glucose control in type 2 diabetes. N Engl J Med. 2008;359:1577-89.

23. Naka K, Papathanassiou K, Bechlioulis A, et al. Determinants of vascular function in patients with type 2 diabetes. Cardiovasc Diabetol. 2012;11.

24. Monnier L, Colette C, Owens DR. Integrating glycaemic variability in the glycaemic disorders of type 2 diabetes: a move towards a unified glucose tetrad concept. Diabetes Metab Res Rev. 2009;25:393-402.

25. Hammes HP. Pathophysiological mechanisms of diabetic angiopathy. J Diabetes Complications. 2003;17:16-9.

26. Aronson D. Hyperglycemia and the pathobiology of diabetic complications. Adv Cardiol. 2008; 45: 1-16.

27. Taguchi S, Oinuma T, Yamada T. A comparative study of cultured smooth muscle cell proliferation and injury, utilizing glycated low density lipoproteins with slight oxidation, auto-oxidation, or extensive oxidation. J Atheroscler Thromb. 2000;7:132-7.

28. Fowler MJ. Microvascular and macrovascular complications of diabetes. Clin Diabetes. 2008;26:77-82.

29. Mónica O, Stephen L, Dan C, et al. Cost effectiveness of strategies to combat cardiovascular disease, diabetes, and tobacco use in sub-Saharan Africa and South East Asia: mathematical modelling study. BMJ. 2012;344.

30. The CDC Diabetes Cost-effectiveness Group. Cost-effectiveness of intensive glycemic control, intensified hypertension control, and serum cholesterol level reduction for type 2 diabetes. JAMA. 2002;287:2542-51.

31. Chew BH, Ghazali SS, Mastura I, et al. Age ≥ 60 years was an independent risk factor for diabetes-related complications despite good control of cardiovascular risk factors in patients with type 2 diabetes mellitus. Exp Gerontol. 2013;48(5):485-91.

32. American Diabetes Association. Standards of medical care in diabetes—2013. Diabetes Care. 2013;36(suppl 1):S11-S66.

33. Tandon N, Ali MK, Narayan KM. Pharmacologic prevention of microvascular and macrovascular complications in diabetes mellitus: implications of the results of recent clinical trials in type 2 diabetes. Am J Cardiovasc Drugs. 2012;12:7-22.

34. Jaakko T. Impact of age on cardiovascular risk: implications for cardiovascular disease management. Atheroscler Suppl. 2004;5:9-17.

35. Hubert K, Berthold S, Lutz H, et al. Type 2 diabetes phenotype and progression is significantly different if diagnosed before versus after 65 years of age. J Diabetes Sci Technol. 2008;2:82-90.

36. Strine TW, Okoro CA, Chapman DP, et al. The impact of formal diabetes education on the preventive health practices and behaviors of persons with type 2 diabetes. Prev Med. 2005;41:79-84.