Ethnic differences among Chinese, Malay and Indian patients with type 2 diabetes mellitus in Singapore

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ABSTRACT

Introduction: Ethnic differences exist in patients with diabetes mellitus. Not much is known about such differences in Asian populations. The aim of the study was to determine ethnic differences among Chinese, Malay and Indian patients with type 2 diabetes mellitus in Singapore.

Methods: The study design was cross-sectional, involving 967 patients who were attending follow-up care for type 2 diabetes mellitus at a primary care clinic. Data collection was by patient interview, examination, and from case records. Blood and urine samples were collected for analysis of indicators of diabetic control and albuminuria.

Results: Malays had the highest mean body mass index (BMI) after controlling for age, gender, duration of diabetes and exercise status. Adjusted mean BMI for Malays was 27.4kg/m^2, Indians 25.7kg/m^2, Chinese 24.9kg/m^2, with the p value being less than 0.01. HbA1c levels were highest among Indians after controlling for age, duration of diabetes, body mass index and treatment. Adjusted mean HbA1c for Indians was 8.3 percent, Malays 8.0 percent, and Chinese 7.7 percent, with the p value being less than 0.01. Compared with Chinese, Indians were more likely to have a positive family history of diabetes (prevalence rate ratio (PRR) of 1.3, 95 percent confidence interval (CI) of 1.0 to 1.7), but were less likely to have associated hypertension (PRR of 0.7, 95 percent CI of 0.5 to 1.0) and microalbuminuria and macroalbuminuria (PRR of 0.6, 95 percent CI of 0.4 to 1.0).

Conclusion: Ethnic differences exist with regard to BMI, diabetic control as reflected by HbA1c levels, family history of diabetes, presence of associated hypertension, and severity of albuminuria. Indians, while having poorer control of diabetes, are less prone to hypertension and renal complications than Chinese.

Keywords: body mass index, diabetes mellitus, hypertension, family history, albuminuria

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INTRODUCTION

It is well known that ethnic differences exist in diabetes mellitus prevalence, and also in susceptibility to some complications. In the United States of America (USA), the risks for diabetes mellitus in African-Americans, Hispanics and Native Americans are approximately 2, 2.5 and 5 times greater, respectively, than in white Americans[1]. Compared with white Americans, African-Americans were more likely to experience symptoms related to diabetic control, but less likely to have symptoms of cardiovascular problems. They were also less likely to have cardiovascular complications[2]. While coronary artery disease is the main cause of mortality in diabetic patients in the West, renal failure and cerebrovascular accident are the leading causes of death among Chinese diabetic patients in Hong Kong[3]. In addition to genetic causes, geographic and social factors are related to increased morbidity and mortality rates in patients with diabetes mellitus[4].

Knowledge of ethnic differences will help doctors manage their patients better, with respect to the prevention of complications. It may also help us to manage gene-environmental interaction. Reports on ethnic differences thus far compared mainly minority groups in the USA with the White population[5,6], and South Asians in the United Kingdom (UK) with Caucasians resident there[7]. Little is known about inter-ethnic differences among patients with diabetes mellitus in South-East Asia. In a recent report on young diabetics aged less than 40 years (both type 1 and type 2) in peninsular Malaysia, Ismail et al noted that, among others, ethnic background and waist-hip ratio were significant predictors of HbA1c levels[8]. Like Malaysia, Singapore is a multi-ethnic nation. Its residents comprise three major ethnic groups of Chinese (76.9%), Malay (14.0%) and Indian (7.7%), and 1.4% other ethnic groups[9]. Of these, Chinese and Indians were migrants from their native countries dating back to the 19th and 20th centuries. In this study, we aimed to compare ethnic differences

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among 967 Chinese, Malay and Indian patients with type 2 diabetes mellitus currently attending follow-up at a primary care clinic in Singapore.

METHODS

The study population consisted of 967 patients with type 2 diabetes mellitus, who were on follow-up at the Toa Payoh Polyclinic in Singapore. Toa Payoh Polyclinic, located in the central region of the Republic of Singapore, is one of 18 public primary care clinics in the country. It provides a wide range of subsidised primary health and medical care services for clients of all ages, serving residents living in areas around the Polyclinic. Diabetic consultations comprised about 11% of all consultations at this Polyclinic[10].

Patients were recruited on a consecutive basis, between April 1995 and June 1997, as they attended the clinic for follow-up. Patients with type 2 diabetes mellitus were defined as patients whose case records satisfied all of the following criteria: (1) either documented diagnosis of diabetes mellitus according to World Health Organisation (WHO) criteria[11] or doctor-diagnosed diabetes mellitus as evidenced from referral letters to the government clinic by general practitioners or hospital specialists, (2) no record of any episode of ketoacidosis[12], as this is unusual in type 2 diabetes mellitus, and (3) those whose documented first line of treatment was dietary restriction alone or oral hypoglycaemics, in order to exclude individuals with type 1 diabetes mellitus. Patients who were on insulin due to secondary drug failure were included. Patients not belonging to any of the three major ethnic groups consisting of Chinese, Malay and Indian were excluded. Informed consent was obtained prior to inclusion in the study. The study methodology did not include any experimentation, or procedures which were outside what was usually done during these visits.

Clinical information was obtained by patient interview, examination, and from case records. Demographic and social variables included date of birth, gender, smoking, alcohol intake and exercise. Clinical variables included family history of diabetes mellitus and related chronic problems, age at diagnosis of diabetes, presence of associated hypertension, complications of diabetes mellitus and current treatment. Hypertension was defined as either documented diagnosis in patient case notes according to WHO criteria[13], or doctor-diagnosed hypertension as evidenced from referral letters by general practitioners or hospital specialists. Body mass index (BMI) was calculated from weight and height measurements taken.

Blood and urine samples were collected on the day of the interview for estimation of mean glycated haemoglobin (HbA1c), fasting or two-hour post-prandial sugar, serum and urine creatinine, and urine albumin. For patients in whom fasting blood sugar was done on the day of the visit, two-hour post-prandial sugar was determined at the next visit, and vice versa. HbA1c was measured by high-performance liquid chromatography (HPLC), blood sugar levels by the glucose oxidase method, serum and urine creatinine by Jaffe's method[14]. Overt clinical nephropathy was defined as serum creatinine level of ≥141 mmol/L, the laboratory normal cut-off value. Urine albumin was estimated by enzyme-linked immunosorbent assay (ELISA) using commercially-available polyclonal antibodies. The values obtained were corrected for urine flow by dividing each sample by urine creatinine value obtained from the same sample, and expressed in mg/mmol creatinine (mg/mmol Cr). Normoalbuminuria was defined as urine albumin excretion of <2 mg/mmol Cr, microalbuminuria 2-20 mg/mmol Cr, and macroalbuminuria >20 mg/mmol Cr[15].

All statistical analysis was performed using the SPSS for Windows statistical package[16], and checked for inaccuracies. Logarithmic transformations were done, where necessary, to improve the normality of distributions for parametric analysis. Geometric means were reported instead of arithmetic means. The number (%) of patients with data for the various laboratory tests were as follows: HbA1c – 917 patients (94.8% of all patients), fasting blood sugar – 846 patients (87.5%), two-hour post-prandial sugar – 680 patients (70.3%), serum creatinine – 936 patients (96.8%), and albuminuria – 962 patients (99.5%).

For univariate analysis, differences among the three ethnic groups were compared using the following tests of significance: analysis of variance (ANOVA) for comparing differences in means and geometric means, Kruskall-Wallis tests for differences in medians, and χ^2 tests for differences in proportions. Bonferroni's tests were used for post hoc pair-wise comparisons. For multivariate analysis, adjusted means were obtained using analysis of co-variance (ANCOVA), controlling for confounding specific to each relationship. Adjusted prevalence rate ratios (PRR), using Chinese as the reference group, were obtained using Cox's regression adapted for use in cross-sectional study designs[17].

RESULTS

There were similar numbers of men (480) and women (487) in the study. Mean age was 61 years, median was 62 years, with a range of 28 – 87 years. Ethnic differences existed in family history of diabetes mellitus, age at diagnosis, associated hypertension, BMI, diabetic

Table I. Differences in personal and clinical variables by ethnic group.

Variable		Ethnic group number (%) Chinese (n=792)	Malay (n=69)	Indian (n=106)	p value
Demographics					
Age (years)	Mean	61.6*	56.0*	59.9	<0.001
	SD	10.6	11.0	10.6	
Gender	Male	397 (50.1)	31 (44.9)	52 (49.1)	0.70
	Female	395 (49.9)	38 (55.1)	54 (50.9)	
Lifestyle					
Smoking status	Never	514 (65.1)	49 (71.0)	76 (71.7)	0.27
	Ever	276 (34.9)	20 (29.0)	30 (28.3)	
Alcohol intake	None/occ	748 (95.8)	67 (98.5)	100 (94.3)	0.40
	Regular	33 (4.2)	1 (1.5)	6 (5.7)	
Exercise	None/occ	435 (56.0)	33 (49.3)	60 (57.1)	0.54
	Regular	342 (44.0)	34 (50.7)	45 (50.7)	
Family history					
Diabetes	Yes	293 (37.1)	35 (50.7)	53 (50.5)	<0.01
Hypertension	Yes	210 (26.6)	27 (39.1)	28 (26.7)	0.08
IHD	Yes	85 (10.8)	9 (13.0)	17 (16.2)	0.24
Stroke	Yes	82 (10.4)	11 (15.9)	11 (10.5)	0.36
Clinical variables					
Duration of diabetes (years)	Median	7.0	4.0	6.5	0.11
	Inter-quartile range	9.0	8.0	11.0	
Age at diagnosis (years)	Mean	53.3*	49.4*	51.1	<0.01
	SD	11.3	11.4	11.8	
Hypertension	Yes	378 (47.7)	33 (47.8)	36 (34.0)	0.03
BMI	Mean	24.8**	27.6**	25.7**	<0.01
	SD	3.5	4.9	4.3	
Treatment	Diet only	101 (12.8)	42 (5.8)	12 (11.3)	0.52
	Oral only	654 (82.6)	62 (89.9)	88 (83.0)	
	Insulin ± oral	37 (4.7)	3 (4.3)	6 (5.0)	
Diabetic control					
HbA1c	Geometric mean	7.65*	8.18	8.36*	<0.01
Fasting blood sugar	Geometric mean	8.41	8.80	8.87	0.17
2-hour post-prandial sugar	Geometric mean	10.31	10.12	10.40	0.91
Complications					
Macrovascular					
IHD	Yes	139 (16.7)	9 (13.0)	24 (22.6)	0.20
Stroke	Yes	39 (4.9)	6 (8.7)	4 (3.8)	0.32
Microvascular					
Retinopathy	Yes	87 (15.6)	9 (17.6)	11 (16.4)	0.92
Nephropathy	Serum creatinine ≥ 141 mmol/L	19 (2.5)	3 (4.3)	0 (0.0)	0.16
Albuminuria[a]	Normoalbuminuria	503 (63.8)	44 (64.7)	83 (79.0)	<0.01
	Micro and/or Macroalbuminuria	286 (36.2)	24 (35.3)	22 (21.0)	
	Geometric mean	1.21*	1.09	0.78*	0.04

SD: standard deviation; IHD: ischaemic heart disease; BMI: body mass index

* Statistically-significant pairwise ($p<0.05$) by Bonferroni test

** Statistically-significant ($p<0.05$) between Chinese and Malay, and Indian and Malay, by Bonferroni test

[a] Normoalbuninuria: urine albumin <2 mg/mmol creatinine
Microalbuminuria: urine albumin 2-20 mg/mmol creatinine
Macroalbuminuria: urine albumin >20 mg/mmol creatinine

Table II. Adjusted means of selected variables by ethnic group.

Variable	Ethnic group Adjusted means			p value
	Chinese	Malay	Indian	
Age at diagnosis (years)[a]	53.1	50.8	52.0	0.18
Body mass index (kg/m^2)[b]	24.86**	27.39**	25.65**	<0.01
HbA1c (%)[c]	7.68*	7.97	8.31*	<0.01
Albuminuria (mg/mmol Cr)[d]	1.19	1.14	0.85	0.13

Variables adjusted for by analysis of co-variance (ANCOVA):

[a] family history of diabetes, family history of hypertension, body mass index and associated hypertension.

[b] age, gender, exercise status and duration of diabetes.

[c] age, duration of diabetes, body mass index and treatment.

[d] age and hypertension status.

* Statistically-significant pairwise ($p<0.05$) by Bonferroni test.

** Statistically-significant ($p<0.05$) between Chinese and Malay, and Indian and Malay, by Bonferroni test.

Table III. Factors associated with mean body mass index (BMI).

Variable		BMI (kg/m^2) unadjusted mean	p value
Age group (years)	<50	26.1	<0.01
	50 to <70	25.2	
	≥70	24.3	
Gender	Male	24.9	0.02
	Female	25.4	
Duration of diabetes (years)	<10	25.5	<0.01
	≥10	24.5	
Exercise status	None/occ	25.6	<0.01
	Regular	24.6	

control as measured by HbA1c levels, and the severity of albuminuria (Table I). Malay patients were younger (mean age 56.0 years), but this could be because of the younger age at diagnosis in Malays. More than one-half of Malay and Indian patients had positive family history of diabetes mellitus compared with 37.1% of Chinese patients. A higher proportion of Chinese and Malay patients had associated hypertension, compared with Indians. When patients with overt nephropathy (serum creatinine ≥141 mmol/L) were excluded, the difference remained (% with hypertension: Chinese 47.3%, Malay 45.5%, Indian 31.3%, p=0.01).

It was interesting to note that Malays had the highest BMI. In fact, Malay women had the highest mean BMI (28.8 kg/m^2), followed by Indian women (27.0 kg/m^2) and Malay men (26.2 kg/m^2). Diabetic control was less satisfactory among Indian and Malay patients compared with Chinese. As for albuminuria, fewer Indian patients had microalbuminuria (21.0%) compared with Chinese and Malay patients (30.0% and 35.3%, respectively). Only Chinese patients (6.2%) had macroalbuminuria. Although there was no statistically-significant difference in the complication rates among the three ethnic groups except for albuminuria, of note is the higher proportion of Indian patients with ischaemic heart disease (22.6%) compared with Chinese (16.7%) and Malays (13.0%). There was no difference in social or exercise habits among the three ethnic groups. A higher proportion of Chinese had ever smoked compared with Indians and Malays. Only one Malay patient took alcohol on a regular basis (1.5%) compared with six Indians (5.7%) and 32 Chinese (4.1%). The proportions of patients who exercised at least once a week were similar among the three ethnic groups.

Upon controlling for confounders, differences in BMI and HbA1c among the three ethnic groups remained (Table II). Malays still had an earlier age at diagnosis, but the difference was not statistically significant. Patients with a positive family history of diabetes mellitus tended to have their diabetes diagnosed at an earlier age (median age at diagnosis – with family history: 48 years, without family history: 56 years, p<0.01), but this was reversed for those with associated hypertension (median age at diagnosis –

Table IV. Factors associated with mean HbA1c levels.

Variable		HbA1c (%) unadjusted mean	p value
Age group (years)	<50	8.7	<0.01
	50 to <70	8.1	
	≥70	7.4	
Duration of diabetes (years)	<10	7.7	<0.01
	≥10	8.4	
Treatment	Diet only	6.9	<0.01
	Oral only	8.1	
	Insulin ± oral	8.8	

Table V. Adjusted prevalence rate ratios (PRR) of selected variables by ethnic group (Malay and Indian vs Chinese).

Variable	Ethnic group			
	Malay		Indian	
	PRR (95% CI)	p value	PRR (95% CI)	p value
Family history of diabetes[a]	1.13 (0.78 – 1.62)	0.52	1.29 (0.96 – 1.73)	0.09
Family history of hypertension[b]	1.19 (0.79 – 1.81)	0.41	0.94 (0.63 – 1.40)	0.75
Hypertension[c]	0.89 (0.61 – 1.30)	0.54	0.66 (0.45 – 0.97)	0.03
Ischaemic heart disease[d]	0.80 (0.37 – 1.71)	0.56	1.39 (0.86 – 2.26)	0.18
Micro- and/or macroalbuminuria[e]	1.04 (0.69 – 1.59)	0.84	0.64 (0.41 – 0.99)	0.05

Variables adjusted for by Cox's regression:

[a] age, family history of hypertension, duration of diabetes and body mass index.

[b] age, family history of diabetes, hypertension and body mass index.

[c] age, family history of hypertension, body mass index and HbA1c.

[d] age, smoking status and HbA1c.

[e] age, hypertension, duration of diabetes and HbA1c.

with hypertension: 54 years, without hypertension: 52 years, p<0.01). Adjusted mean BMI remained higher in Malays. Older patients were leaner compared with younger ones (BMI in patients ≥70 years: 24.3 kg/m^2; 50<70 years: 25.2 kg/m^2; <50 years: 26.1 kg/m^2, p<0.01). Men and those who exercised regularly at least once a week had lower BMI values (mean BMI – males: 24.9 kg/m^2, females: 25.4 kg/m^2, p=0.02; those who exercise: 24.6 kg/m^2, who do not exercise: 25.6 kg/m^2, p<0.01). Patients who had diabetes mellitus for a longer duration of time were also thinner (mean BMI – diabetes duration <10 years: 25.5 kg/m^2, ≥10 years = 24.5 kg/m^2, p<0.01) (Table III).

For diabetic control, Indians still had the highest adjusted mean HbA1c levels (8.3%). Older patients had better diabetic control compared with younger ones (mean HbA1c – <50 years of age: 8.7%, 50 to <70 years: 8.1%, ≥70 years: 7.4%, p<0.01). Conversely, patients with longer duration of diabetes had higher HbA1c levels (mean HbA1c – diabetes duration <10 years: 7.7%, ≥10 years: 8.4%, p<0.01). Patients who were on insulin had poorer diabetic control compared with those on oral medications and who were on dietary control alone (mean HbA1c – insulin±oral: 8.8%, oral only: 8.1%, diet only: 6.9%, p<0.01) (Table IV). Compared with Chinese, Indians were less likely to have associated hypertension (PRR: 0.66, 95% CI: 0.45-0.97), and micro- and macroalbuminuria (PRR: 0.64, 95% CI: 0.41-0.99), but more likely to have a positive family history of diabetes (PRR: 1.29, 95% CI: 0.96-1.73). Adjusted PRR for ischaemic heart disease in Indians was 1.39, but this was not statistically significant (95% CI: 0.86-2.26) (Table V).

DISCUSSION

In this study on 967 Chinese, Malay and Indian patients with type 2 diabetes mellitus, we found that there were ethnic differences in BMI, diabetic control, family history of diabetes mellitus, prevalence of associated diabetes mellitus and severity of albuminuria. Malays were the most overweight, followed by Indians and Chinese. Indians had the poorest three month diabetic control, followed by Malays and Chinese. Compared with Chinese, Indians were also more likely to have a positive family history of diabetes mellitus, but less likely to have associated hypertension and micro- and

macroalbuminuria. For the Malay patients, being overweight is most likely not due to diabetes mellitus, as this is also a finding in the general population. Data from the Singapore National Health Survey conducted in 1998 showed that the prevalence of obesity (BMI >30 kg/m^2) was highest among Malays (16.2%), followed by Indians (12.2%) and Chinese (3.8%)[18]. Obesity was particularly common among Malay and Indian women. In another population-based survey conducted in Singapore, Hughes et al reported that although there was little ethnic difference in BMI in males aged 18 to 69 years, differences among females were marked. Compared with Chinese women, 9.4% more Malay women and 7.0% more Indian women were obese[19].

In our study, diabetic control was most optimal among the Chinese, followed by Malays and Indians. In peninsular Malaysia, Ismail et al also found that diabetic control was best among the Chinese in 926 young diabetics aged <40 years[8]. Other predictors of better diabetic control included older age group, shorter duration of diabetes mellitus and treatment by diet alone. The seeming contradiction of age and duration of diabetes mellitus can be explained by the study design. As this was a cross-sectional study, patients who were younger in age included more of those whose diabetes mellitus was diagnosed recently, and who were yet to achieve optimal control. Patients with longer duration of diabetes mellitus, on the other hand, had more severe disease, and hence control would, as expected, be poorer. Similarly, mode of treatment is a surrogate measure of severity of disease. Patients who required insulin had more severe disease than those who required oral medications. Patients whose diabetes mellitus could be controlled by dietary restriction alone obviously had the mildest form of disease.

Ethnic differences in control of diabetes could also be affected by factors not looked into in our study, such as socio-economic status[4], availability of health care facilities[8], insulin sensitivity[6], among others. We found that more Indian patients had a positive family history of diabetes mellitus compared with Chinese. This was consistent with the higher prevalence of diabetes mellitus among Indians in Singapore. In the 1998 National Health Survey, the prevalence of diabetes mellitus was highest in Indians (12.9%), followed by Malays (9.3%) and Chinese (8.1%)[18]. This may indicate a genetic predisposition among the Indians, in addition to effect of migration, as a high prevalence of diabetes mellitus was found among migrant Asian Indians in many countries, such as South Africa (13%), Fiji (14%), Mauritius (17%)[20], Canada (prevalence among South Asians was 10%, compared with 5% in Chinese and 6% in Europeans)[21], and the UK[22-24].

In addition to the above findings, we also found that, compared with Chinese, Indian patients were less likely to have associated hypertension and albuminuria. There have been no previous studies comparing Chinese with Indians in these aspects. Compared with the white population in the UK, Indians have higher prevalence of proteinuria[25]. In an Australian study comparing six different ethnic groups with Anglo-Celtics, both Chinese and Indians had a lower risk of hypertension but higher risk of albuminuria[26]. Further studies could be conducted to examine the difference in susceptibility to renal complications between Chinese and Indians.

Ethnic differences in diabetes mellitus are due to both genetic and environmental factors. At present, although little can be done with regard to gene manipulation, environmental changes can and do modify the susceptibility of patients to complications of diabetes mellitus. Knowledge of ethnic differences will help in the planning of practical preventive strategies to delay the onset of complications, and enable doctors to manage their patients better. Malays in particular should be targeted in strategies on lifestyle changes to prevent the onset of obesity. Dietary advice and cooking tips could be tailored to the preparation of Malay food. As more Indians have a positive family history of diabetes mellitus, they should be encouraged to come forward for screening for diabetes mellitus. As doctors know that diabetic control is least optimal among the Indians, they should learn more about the health beliefs and dietary habits of their Indian patients, so as to be able to give advice that are culturally acceptable to their patients.

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