Socioeconomic profile of diabetic patients with and without foot problems

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Introduction: To identify the differences in a socioeconomic profile between two cohorts of diabetic patients – one with diabetic foot problems and another without diabetic foot problems.

Materials and methods: The cohort with diabetic foot problems (including cellulitis, abscess, osteomyelitis, septic arthritis, gangrene, ulcers, or Charcot joint disease) consisted of 122 diabetic patients, while the other cohort without foot problems consisted of 112 diabetic patients. Both were seen at the National University Hospital from January to April 2007. A detailed protocol was designed and the factors studied included patient profile, average monthly household income, education, compliance to diabetic medication, attendance at clinics for diabetic treatment, exercise, smoking, alcohol consumption, gender, and glycosylated haemoglobin (HbA_{1c}) level. These were studied for significant differences using univariate and stepwise multivariate logistic regression analysis.

Results: With multivariate analysis, Malay ethnicity ($p < 0.001$), education of up to secondary school only ($p = 0.021$), low average monthly household income of less than SGD \$2,000 ($p = 0.030$), lack of exercise (at least once a week, $p = 0.04$), and elevated HbA_{1c} level ($> 7.0\%$; $p = 0.015$) were found to be significantly higher in the cohort with diabetic foot problems than the cohort without.

Conclusions: There are significant differences in the socioeconomic factors between diabetic patients with diabetic foot problems and those without.

Keywords: *diabetic foot; social conditions; patient compliance; income; HbA_{1c}*

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Diabetic foot problems are serious complications of diabetes mellitus as they cause significant morbidity and mortality. In Singapore, diabetes mellitus is on the rise (1) and its current prevalence is approximately 8.2% (2). Diabetic foot problems account for 10–20% of emergency admissions in the Department of Orthopaedic Surgery, National University Hospital, and 27.2% of limb loss – below and above knee amputations (3). In Singapore, almost 700 lower extremity amputations resulting from diabetic foot problems are performed annually (4).

In view of the increasing disability, rising health care costs, and reduction of the quality of life of diabetic patients that arise from diabetic foot problems (5), the multifactorial reasons for the development of diabetic foot problems have been gaining attention in recent years. Various factors have been shown to predispose these

patients to diabetic foot problems. These include sensory neuropathy and peripheral vascular disease (6, 7). The epidemiology of diabetic foot problems and the predictive factors for limb loss have been studied by Nather et al. (3).

Low socioeconomic status is often associated with the occurrence of several chronic diseases (8) and poor socioeconomic factors have been empirically accepted as a risk factor for the development of diabetic foot problems (6). However, the role of socioeconomic factors in Asian populations, like that of Singapore's, has not been well studied (5). The objective of this study was to investigate the differences, if any, between the socioeconomic profiles of one cohort of patients presenting with diabetes mellitus and diabetic foot problems to the orthopaedic surgeon, and another cohort presenting with diabetes mellitus and no diabetic foot problems to the endocrinologist at the National University Hospital.

Factors studied in each cohort of patients included population profile, education level, financial status, and compliance to medical treatment.

Material and methods

The study design is a non-randomised case study using two cohorts of patients with similar proportions of gender seen at the National University Hospital. The first cohort consisted of 122 consecutive patients with diabetes mellitus and diabetic foot problems presented to the Diabetic Foot Team Clinic of the Department of Orthopaedic Surgery, National University Hospital. Diabetic foot problems included cellulitis, abscess, osteomyelitis, septic arthritis, gangrene, and Charcot joint disease. These were diagnosed clinically along with the aid of laboratory and radiological investigations, such as a full blood count, C-reactive protein, erythrocyte sedimentation rate, and X-rays of the affected limb. The other cohort was made up of 112 consecutive patients with diabetes mellitus but without diabetic foot problems presented to the Diabetic Clinic of the Division of Endocrinology, National University Hospital. Prior to inclusion in the study, the objective of the study and the interview protocol were explained to the patient and informed consent was taken. None of the patients approached declined to participate in the study. Approval was obtained from the Institution Review Board Ethics Committee of National University Hospital before the study was carried out.

A detailed interview protocol was designed for this study. This included age, gender, ethnicity (Chinese, Indian, Malay, and others), marital status, and type and duration of diabetes mellitus. In addition, highest education level (no education, primary, secondary, junior college, diploma, and university), employment status, average monthly household income (high, middle, and low), type of housing (public housing offered to Singapore residents and citizens under the Housing and Development Board, HDB: one-, two-, three-, four-, and five-room flats, executive flats, private flat/condominium, or private housing), size of family, and caregiver support were also recorded. Other factors that were investigated included control of diabetes mellitus and compliance to medication (good, average, poor, or not taking medication), attendance at clinics for diabetic treatment (good, average, poor, or not attending clinics for diabetic treatment), smoking, and alcohol consumption. Patients were also asked about their frequency of exercise (once a week or more) and their glycosylated haemoglobin (HbA_{1c}) levels were taken at the time of the interview and recorded.

For analysis, education was grouped into junior college (two years pre-university, post-secondary education), above (consisting of junior college, polytechnic, and university), and up to secondary (four years post-primary

education for those usually aged 13–16). Those who did not receive education and those with primary education only (aged 7–12) were included in the latter group. Also grouped was the average monthly household income into low (less than \$2,000 Singapore Dollars, SGD), middle (SGD \$2,000–\$8,000), and high (above SGD \$8,000). The national average monthly income was SGD \$7,090 (9). In addition, the type of housing was included as it is an indicator of household income. Unlike most developed countries, a large majority (87.7%) of Singaporeans resided in public housing by the HDB (9). Living in one- and two-room HDB flats indicated that patients belonged to the low income group as their gross monthly household income must not exceed SGD \$2,000 in order for them to be eligible for HDB flats (10).

Compliance to diabetic medication was gaged by the percentage of occasions the patient adhered to taking his medicine at stipulated times over the past 12 months. For those who took their diabetic medicine consistently for more than 90% of the time, their compliance was good. Compliance of less than 50% of the time was considered poor. Compliance between 50% and 90% was considered to be average. Attendance at polyclinics and diabetic clinics for diabetic treatment was likewise grouped into 'good,' 'average,' and 'poor' depending on the percentage of appointments that the patients fulfilled over the past 12 months. For those who attended more than 90% of their appointments, they were considered to have good attendance. Attendance of less than 50% was considered poor. Attendance between 50 and 90% was considered to be average.

Statistical analysis was carried out using the Statistical Package for the Social Sciences version 14. A univariate logistic regression and multivariate analysis were subsequently conducted to evaluate significant differences in socioeconomic factors between the two cohorts of diabetic patients – one with and the other without diabetic foot problems.

Results

In the first cohort of 122 patients with diabetic foot problems, there were 66 males (54.1%) and 56 females (45.9%) with a male to female sex ratio of 1.18:1. Their ages ranged between 24 and 91 years with a mean of 59.8 years. There were 56 Chinese (45.9%), 42 Malays (34.4%), 20 Indians (16.4%), and 4 of other ethnicities (3.3%). There were 40 patients who presented with diabetic foot ulcers, with another 40 patients presenting with gangrene. Thirty-one patients presented with infection (abscess, osteomyelitis, or septic arthritis), with 8 patients presenting with cellulitis, followed by 3 patients with Charcot joint disease.

In the second cohort of 112 diabetic patients without any diabetic foot problems there were 53 males (47.3%) and 59 females (52.7%) with a male to female sex ratio of

0.9:1. Their ages ranged between 21 and 85 years with a mean of 60.5 years. There were 71 Chinese (63.4%), 14 Malays (12.5%), 22 Indians (19.6%), and 5 of other ethnicities (4.5%).

With univariate analysis (Table 1), the factors that were significantly higher in the diabetic foot problem cohort included Malay ethnicity ($p < 0.001$), singlehood ($p = 0.043$), highest education level of up to secondary school ($p < 0.001$), low average monthly household income of less than SGD \$2,000 ($p < 0.001$), poor compliance to diabetic medication ($p = 0.020$), smoking ($p = 0.022$), lack of exercise (less than once a week; $p < 0.001$), and high HbA_{1c} levels ($> 7.0\%$; $p < 0.001$).

No significant difference was observed between the two groups with regards to gender, age, attendance at clinics for diabetic treatment, and alcohol consumption ($p > 0.05$).

With multivariate analysis, the factors that were significantly higher in the diabetic foot problem cohort included Malay ethnicity ($p < 0.001$), an education level of up to secondary school ($p = 0.021$), an average monthly household income of less than SGD \$2,000 ($p = 0.030$), lack of exercise (less than once a week; $p = 0.04$), and high HbA_{1c} levels ($> 7.0\%$; $p = 0.015$).

Discussion

This is the first prospective study carried out in Singapore comparing the socioeconomic profile of two cohorts of diabetic patients – one with diabetic foot problems and the other without diabetic foot problems.

In Singapore, the types and incidences of diabetic foot problems include gangrene (31.7%), infection (abscesses or osteomyelitis; 28.7%), ulcers (27.7%), cellulitis (6.4%), necrotising fasciitis (3.5%), and Charcot's osteoarthropathy (2.0%; 3). Nather et al. (3) found that certain factors such as peripheral vascular disease, sensory neuropathy, gangrene, and infection with methicillin-resistant *Staphylococcus aureus* are predictive for major amputations in diabetic patients with diabetic foot problems.

This study aims to evaluate the differences between these two cohorts of diabetic patients and also to identify socioeconomic factors that would predispose diabetic patients to develop diabetic foot problems. This study would allow identification of high risk patient groups that would benefit from stringent glycaemic control and diabetic foot care education, leading to a decrease in the incidence and potential complications of diabetic foot problems in our population.

Ethnicity

When comparing our two study cohorts against the racial distribution of Singapore's national population (11), our study found diabetic patients of Malay ethnicity to be disproportionately higher in the cohort with diabetic foot

problems ($p < 0.001$) on multivariate analysis as compared with other ethnicities; namely, Chinese and Indian.

Although no study has been conducted on Malay ethnicity as a risk factor in the development of diabetic foot problems, ethnicity – in particular minority ethnic groups – was often found to be a key socio-economic factor in the study of diabetic foot problems (5, 12). Young et al. (5) found in their study of 429,918 diabetic patients that Native Americans, who comprised of the smallest minority population, had the highest risk of lower extremity amputation (1.7-fold) while African Americans and Hispanics had a higher risk (1.4-fold and 1.2-fold, respectively) when compared against the white population. Besides the rates of amputations, there was also variation in the level of amputations among ethnic groups. Young et al. (5) noted that Asian patients were much more likely to have toe amputations while Native American patients had the highest percentage of below knee amputations. Differences among ethnic groups occur despite the fact that the various ethnic groups received the same care. Thomas et al. (12) concluded that even when attending the same general practice and receiving comparable care, Indigenous Australians had more diabetic complications than non-Indigenous patients.

Interestingly, not all ethnic minorities suffer from a higher risk of diabetic foot problems (5, 13). Weng et al. (13) observed that in their study of 610 patients in Greater London, Afro-Caribbeans had better diabetic control than whites. Young et al. (5) noted that Asians had a 69% lower risk of amputation when compared with whites. However, Young et al. (5) did not study if there were differences among the different Asian ethnicities. In our study, we compared the differences between Chinese, Malays, and Indians in our multi-ethnic population and found Malay ethnicity to be of greater significance among diabetic patients with diabetic foot problems.

Nonetheless, there are studies that concluded that ethnicity is not a risk factor in the development of diabetic foot problems (6, 14). Resnick et al. (14) reported that the risk of lower amputation for African Americans when compared with whites was not statistically significant. Also, Peters et al. (6) did not find a difference in lower extremity infection between diabetic Mexican Americans and whites in his study of 112 patients.

Average monthly household income

Upon multivariate analysis, we found a higher incidence of patients with low average monthly income of less than SGD \$2,000 in the cohort with diabetic foot problems ($p = 0.030$). Low average monthly income has been associated with worse diabetic outcomes (15, 16) as it determines the ability to obtain medication and services that improve health (17, 18). Oladele and Barnett (15) found a strong association between the level of social

Table 1. Comparison of factors between diabetic patients with diabetic foot problems versus diabetic patients without diabetic foot problems

	Diabetic foot problem group (N = 122) (%)	Non- diabetic foot problem group (N = 112) (%)	Univariate analysis		Multivariate analysis	
			P-value	OR (95% CI)	P-value	OR (95% CI)
Gender						
Female	45.9	52.7		1.0		1.0
Male	54.1	47.3	0.301	1.31 (0.78–2.19)	0.068	1.96 (0.95–4.04)
Age (mean $\pm$ SD)	59.8 $\pm$ 13.4	60.5 $\pm$ 13.0	0.708	0.99 (0.98–1.02)	0.713	1.01 (0.98–1.04)
Ethnicity						
Chinese	45.9	63.4		1.0		1.0
Malay	34.4	12.5	<0.001	3.80 (1.89–7.65)	<0.001	5.37 (2.22–12.98)
Indian	16.4	19.6	0.691	1.15 (0.57–2.32)	0.919	0.95 (0.38–2.42)
Others	3.3	4.5	0.984	1.01 (0.26–3.95)	0.216	2.73 (0.56–13.45)
Marital status						
Married	62.3	73.1		1.0		1.0
Divorced	4.1	3.6	0.664	1.35 (0.35–5.21)	0.577	0.62 (0.12–3.26)
Single	13.9	6.3	0.043	2.62 (1.03–6.66)	0.131	2.72 (0.74–9.96)
Widowed	19.7	17.0	0.371	1.36 (0.69–2.68)	0.872	1.08 (0.41–2.82)
Education level						
JC and above	7.4	27.7		1.0		1.0
Up to secondary	92.6	72.3	<0.001	4.80 (2.17–10.64)	0.021	3.41 (1.21–9.62)
Average monthly household income (SGD)						
High ($\geq$ 8000)	4.1	18.9		1.0		1.0
Low ($<$ 2,000)	64.2	28.8	<0.001	10.06 (3.50–28.92)	0.030	4.39 (1.16–16.67)
Middle (2,000–7,999)	31.7	52.3	0.061	2.75 (0.96–7.92)	0.430	1.68 (0.43–2.25)
Compliance to diabetic medication						
Good	75.4	83.9		1.0		1.0
Poor	9.8	1.8	0.020	6.13 (1.33–28.15)	0.360	2.48 (0.35–17.51)
Average	5.7	2.7	0.218	2.38 (0.60–9.50)	0.924	1.09 (0.18–6.63)
N/A	9.1	11.6	0.738	0.86 (0.37–2.03)	0.426	1.68 (0.47–6.06)
Attendance at polyclinic/ diabetic clinic for diabetic treatment						
Good	83.6	90.2		1.0		1.0
Poor	5.7	0.0	0.999	100 (0.1–1000)	0.999	100 (0.1–1000)
Average	5.7	5.4	0.801	1.16 (0.37–3.55)	0.097	0.26 (0.05–1.27)
N/A	4.9	4.4	0.781	1.19 (0.35–4.02)	0.151	0.29 (0.05–1.58)
Smoking						
No	87.7	96.4		1.0		1.0
Yes	12.3	3.6	0.022	3.78 (1.22–11.77)	0.224	2.77 (0.54–14.34)
Alcohol consumption						
No	92.6	98.2		1.0		1.0
Yes	7.4	1.8	0.063	4.38 (0.93–20.73)	0.320	3.23 (0.32–32.68)
Exercise frequency						
At least once a week	33.6	58.0		1.0		1.0
Less than once a week	66.4	42.0	<0.001	2.73 (1.61–4.65)	0.04	2.06 (1.03–4.10)

Table 1 (Continued)

	Diabetic foot problem group (N = 122) (%)	Non- diabetic foot problem group (N = 112) (%)	Univariate analysis		Multivariate analysis	
			P-value	OR (95% CI)	P-value	OR (95% CI)
HbA1 _C						
≤7.0%	24.6	53.6		1.0		1.0
>7.0%	75.4	46.4	<0.001	3.54 (2.03–6.16)	0.015	2.41 (1.19–4.89)

Note: Bolded values are significant at $P < 0.05$.

class and preventive practices. Dunlop et al. (16) showed that the wealthy were twice as likely to be referred on to specialty care.

On the other hand, Gulliford and Mahabir (19) did not find employment status, which directly determines income, to be significant in the development of diabetic morbidity in their sample of 622 diabetics in Trinidad. Also, Vaidya et al. (20) did not find a strong association between socioeconomic deprivation and diabetic foot ulceration in their population of 666 diabetic patients.

Education

In this study, the highest education level obtained by diabetic patients with diabetic foot problems was significantly lower than those without diabetic foot problems ($p = 0.021$) on multivariate analysis. Indeed, education is usually seen as the key to better health as it facilitates an individual to better utilise health information and treatment (17, 21, 22). Delbridge et al. (22) noted a significant relationship between the level of patient understanding of diabetes mellitus and diabetic foot problems and the development of foot lesions in a cohort of 80 diabetic patients. Bachmann et al. (17) measured education in terms of schooling received and reported more severe complications amongst patients who had received less education. The less educated were also more likely to be seen as non-compliant by health professionals and used less hospital care. Karter et al. (21) showed that in their study of 8,763 diabetic patients, patients with less education had significantly lower predicted probabilities of being a non-smoker, engage in regular exercise, and health-seeking behaviours. However, self-monitoring of blood glucose and foot self-examination did not vary by education. In contrast, Peters et al. (6) and Lavery et al. (23) did not find education to be a significant factor predicting diabetic foot problems.

Glycosylated haemoglobin (HbA1_C) level

Poor glycaemic control, as indicated by HbA1_C levels higher than 7%, was significantly higher in the group with diabetic foot problems upon multivariate analysis. Bresäter

et al. (24) also found significant differences in the level of HbA1_C and fasting blood glucose. Sruissadaporn et al. (25) found poorer glycaemic control in their cohorts of diabetic patients with diabetic foot problems as compared to their cohorts without. On the other hand, Delbridge et al. (22) differed by showing that HbA1_C were similar for diabetics with and without diabetic foot problems.

Exercise

Upon multivariate analysis, the number of patients who did not exercise at least once weekly was found to be significantly higher in the cohort with diabetic foot problems than in the cohort without diabetic foot problems (at least once a week; $p = 0.04$).

Cigarette smoking

Cigarette smoking was not found to be a significant factor in the multivariate analysis of our results. Similarly, Boyko et al. (7) found no relationship between foot ulcers and smoking or the amount smoked in their study of 749 diabetic men. On the other hand, contrasting results were presented by Delbridge et al. (22) who noted an increased incidence of lesions among diabetic patients who smoked and had vascular impairment.

Alcohol consumption

The consumption of alcohol was not found to be a significant risk factor in the development of diabetic foot problems in our study. However, Bresäter et al. (24) found that alcohol problems were more common (32%) in the group of diabetic men with diabetic foot problems compared with 9% in the diabetic group without diabetic foot problems.

Gender

Gender was not statistically significant in our study. In contrast, gender differences between men and women in the development of diabetic foot problems have been observed in other studies (5, 23, 24). Lavery et al. (23) reported that males were a significant risk factor in their study of 225 diabetics. Young et al. (5) found that the risk of amputation in women was 69% lower than that of

diabetic men. Bresäter et al. (24) noted higher divorce rates in the cohort of diabetic men at 25% as compared to the 8% noted in the group without foot problems. They felt that men were less likely to take care of their foot problems or did not have a partner who could help them.

Conclusion

This study evaluated the differences between the socio-economic profiles of one cohort of diabetic patients with diabetic foot problems with another cohort of diabetic patients without diabetic foot problems. Malay ethnicity, education of up to secondary school level only, low average monthly household income of less than SGD \$2,000, lack of weekly exercise, and the HbA_{1c} value of more than 7% were found to be more significant among diabetic patients with diabetic foot problems. Good glycaemic control and diabetic foot care education should be implemented to these high risk patient groups in order to reduce the incidence and potential complications of diabetic foot problems.

Conflict of interest and funding

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