

## Health-related Quality of Life is Associated with Diabetic Complications, but not with Short-term Diabetic Control in Primary Care

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### Abstract

**Introduction:** Type 2 diabetes mellitus is of increasing healthcare concern worldwide, with incidence rising, complications leading to significant morbidity and mortality, posing strain on public healthcare funding. Health-related quality of life of diabetic patients is increasingly being recognised as “the ultimate goal of all health interventions”. The aim of our study was to identify the quality of life predictors of diabetic patients in primary care. This study was conducted in 8 public primary care polyclinics from SingHealth Polyclinics. **Materials and Methods:** We carried out a cross-sectional, questionnaire-based survey on 699 diabetic patients, administered by medical students on a systematic sample of patients during their routine visit. Multiple regression analysis was used to investigate the socio-demographic and clinical characteristics as predictors of quality of life, measured by the Short Form 36 Health Survey (SF-36) and the EQ-5D self-report questionnaire. **Results:** Higher quality of life in diabetic patients is associated with younger age, male gender, employed status, higher educational level and exercise. Lower quality of life is associated with comorbidities and diabetic complications. Short-term glycaemic control as measured by HbA1c did not correlate with quality of life. Most interestingly, confidence in doctor and satisfaction in clinic were related to better quality of life. **Conclusion:** Health-related quality of life is adversely associated with symptomatic complications of diabetes mellitus, but not with short-term diabetic control. This suggests that the diabetic patient may not appreciate the impact of good diabetic control immediately on his or her health-related quality of life. More effort should be invested into patient education of the importance of glycaemic control to prevent these long-term complications.

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### Introduction

Type 2 diabetes mellitus is a major chronic disease globally. With increasing life expectancy, long-term complications of diabetes mellitus leading to significant morbidity and mortality have great impact on each patient’s health. Health-related quality of life refers to a person’s self-perceived functioning and well-being, and is increasingly used to measure how chronic illnesses interfere with a person’s day-to-day life. It has been regarded as “the ultimate goal of all health interventions”.<sup>1</sup>

Previous studies on health-related quality of life in diabetic patients have shown that poorer health-related quality of life is related to older age,<sup>2</sup> female gender,<sup>3</sup> lower educational level and lower economic status,<sup>4</sup> longer duration of diabetes,<sup>5</sup> presence of diabetic complications and concomitant diseases,<sup>6</sup> However, factors such as glycaemic control showed variable results in their association with quality of life. It was an important predictor of quality of life in some studies,<sup>7-8</sup> but had no correlation with quality of life in other studies.<sup>9-11</sup>

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In Singapore, diabetes mellitus was found to affect 8.2% of the population in the 2004 National Health Survey.<sup>12</sup> It was the 5<sup>th</sup> most common medical condition, and was associated with a 3-fold increase in mortality contributing as the 8<sup>th</sup> most common cause of death.<sup>13</sup> One local population health survey showed that the presence of diabetes reduces health-related quality of life,<sup>14</sup> while another showed that ethnicity is associated with health-related quality of life in our multi-ethnic population.<sup>15</sup> It should be noted that these findings were based on a relatively small sample of respondents (n = 309) whose diabetic status was self-reported.

Diabetes mellitus is a chronic disease with significant impact on the health of our population; however there is poor adherence with treatment and follow-up, leading to sub-optimal control. We hypothesise that both socio-demographic and clinical characteristics are associated with health-related quality of life, which could be the missing link. In this present study, we sought to understand the predictors of health-related quality of life in type 2 diabetes mellitus patients in Singapore, with the hope to identify modifiable risk factors that can be modified to improve their quality of life in future. We opted to conduct our study in the primary healthcare setting, as this is where the majority of patients with diabetes receive most of their care, in an effort to better comprehend their profile and needs.

## Materials and Methods

### Study Design

This cross-sectional questionnaire survey was conducted by a group of medical students from Yong Loo Lin School of Medicine, National University of Singapore, from 6 to 12 January 2009 in 8 SingHealth Polyclinics in Singapore, including Bedok, Bukit Merah, Geylang, Outram, Pasir Ris, Queenstown, Seng Kang, and Tampines Polyclinics. Marine Parade Polyclinic was closed for renovation during this period of time and thus was excluded from the study.

During the study period, recruiters were stationed at the clinical laboratory of the polyclinics. Over the operating hours of the clinics, all patients coming to the laboratory were approached. All type 2 diabetic patients above 21 years of age on follow-up at SingHealth Polyclinics who had the glycosylated haemoglobin (HbA1c) test on the day of survey as part of their routine 3-monthly visit, and who were able to communicate and give informed consent were identified. We used a systematic sampling method to recruit every other eligible type 2 diabetic patient to the study.

After written consent was obtained, each patient was interviewed by a trained interviewer. Patients competent in the English, Chinese, or Malay were also given the option to self-administer the questionnaire survey. In the event that the patient was illiterate and was not able to communicate

well with the interviewer, his or her caregiver would be the administrator. The patients were aware that they were free to terminate their participation at any point of time through the conduct of the survey. This project was approved by the Institutional Review Board of SingHealth Polyclinics.

### Instruments

The questionnaire involved 2 parts. The first part consisted of questions on socio-demographic predictor variables including age, language, gender, ethnicity, marital status, education level, type of residence, occupational status, monthly household income, as well as clinical characteristic predictor variables including smoking, duration of diabetes, number of visits to doctor a year, diet control, oral medication, insulin treatment, exercise, compliance to medication, self blood sugar monitoring, comorbidities and complications including stroke, ischaemic heart disease, kidney disease, peripheral neuropathy, eye disease, and peripheral vascular disease. The second part of the questionnaire consisted of 2 quality of life scales: the Short Form 36 Health Survey (SF-36)<sup>16</sup> and the EuroQoL self-report questionnaire (EQ-5D)<sup>17</sup> Both are generic scales that are widely used in various populations for measuring health status and disease burden.

### EQ-5D

The EQ-5D is a standardised instrument designed for measuring general health outcomes.<sup>17</sup> As a generic instrument, it is applicable to a wide range of health conditions. EQ-5D consists of 2 components: the first component is the EQ-5D self-classifier, consisting of 5 dimensions including mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. There are 3 response levels (i.e. no problems, moderate problems, and extreme problems) for each dimension. A health index score can be calculated based on responses to the self-classifier to represent the value of the health status of the respondent from the perspective of the general population. The index score ranges from -0.594 to 1.0, with 0 corresponding to being dead and 1 being full health.<sup>18</sup> Negative scores refer to health states considered worse than death.

The second component of the EQ-5D is a vertical Visual Analog Scale (EQ-VAS) for patients' self-rating of their own health status. On the EQ-VAS, the highest score at the top is 100 which is labelled "best imaginable health state"; the lowest score is 0 at the bottom with a label of "worst imaginable health state". Both the self-classifier and the VAS evaluate the health status of respondents on the day of survey.

The EQ-5D is cognitively simple and takes only a few minutes to complete. The English, Chinese and Malay

versions of the EQ-5D questionnaire for Singapore were validated locally previously.<sup>19-21</sup>

### SF-36

The SF-36 is a multi-purpose survey of functions and well-being, or health-related quality of life.<sup>16</sup> It has proven useful internationally in surveys of healthy and patient populations, for monitoring and comparing disease burden as well as determining the health benefits of different treatments. The SF-36 consist of 36 questions measuring health in 8 domains including physical functioning, role limitation due to physical problems, bodily pain, general health, vitality, social functioning, role limitation due to emotional problems, and mental health. Two summary measures, the physical component summary (PCS) and mental component summary (MCS), can be calculated as weighted sums of 8 SF-36 subscales. PCS and MCS scores are norm-based, with the score of 50 corresponding to the average level of physical function and psychological well-being of the general United States (US) population. Higher PCS and MCS scores indicate better health status.

The English and Chinese versions of SF-36 have been locally validated.<sup>22-24</sup> These, together with a best available Malay version of SF-36 for Singapore, were used in our study.

### Statistical Analyses

The association between health-related quality of life and its potential predictors was examined firstly using univariate analysis and then by multiple linear regression models. In these analyses, health-related quality of life measures including the PCS (SF-36), MCS (SF-36), EQ-5D index, and EQ-VAS scores were treated as continuous variables, whereas all predictor variables, continuous or categorical, were coded into categorical variables, for example, we coded BMI into 3 categories representing underweight (BMI <18.5), normal weight (BMI: 18.5 to 23), and overweight (BMI >23). We elected to treat continuous variables as categorical variables in this study because the relationship between those variables may be non linear.

When coding continuous variables into categorical variables, we tried to generate meaningful categories with sufficient members. The variables we included in our analysis were survey language, mode of questionnaire administration, age, gender, race, marital status, occupational status, housing type, household income, educational level, smoking status, body mass index, duration of diabetes, frequency of visits to the doctor, diabetes control modality, compliance to treatment, self blood sugar monitoring, satisfaction with clinic, confidence in doctor, concerns about diabetes, glycaemic control, presence of diabetes-related

complications, and presence of comorbidities.

In univariate analysis, the association between each quality of life variable and each predictor variable was tested using Independent-samples T test or one-way Analysis of Variance (ANOVA). In multivariate analysis, 4 multiple linear regression models, one for each of the quality of life scores, were used to examine the association between quality of life and their predictors. In these models, only variables showing statistical significance in the univariate analysis were included in the respective regression model(s). Multicollinearity was assessed according to the tolerance and variance inflation factor (VIF) values for all 4 multiple linear models. All statistical testes were 2-sided with at the significance level of 0.05 and all analyses were performed with SAS for Windows (Version 9.1).

### Results

We screened a total of 5266 patients, of whom 2216 were eligible patients. We invited 1020 to participate, in accordance to our sampling frame, in our survey and had an overall response rate of 72.5%. Seven hundred and thirty-nine of these patients consented. Of the 739 surveys, 699 were completed with no missing data for any of the 4 quality of life scores. Only data from the 699 completed surveys were included in the data analysis.

Socio-demographic and clinical characteristics of patients are presented in Table 1, Quality of life scores by socio-demographics, clinical treatment-related variables, complications and comorbidities are presented in Table 2. Multiple regression analysis for PCS, MCS, EQ-5D index, and EQ-VAS scores are presented in Table 3.

The regression models contained up to 16 independent variables, which is acceptable given that on average there were more than 30 observations per variable. The VIF values of the independent variables were lower than 1.5 in all 4 models, suggesting no multicollinearity. Factors that had positive association with higher quality of life scores included: higher household income, lower concern about diabetes, higher satisfaction with clinic, higher confidence in doctor and fewer number of comorbidities. It is also interesting that Indians had a lower EQ-5D index score compared to Chinese. Also, females had a lower EQ-5D index score as compared to males. Diabetes-related factors that were associated with higher quality of life scores included control of diabetes with exercise and absence of complications including stroke, ischaemic heart disease, peripheral neuropathy, eye disease and peripheral vascular disease.

### Discussion

Diabetes mellitus is a chronic disease with high morbidity

Table 1. Socio-demographic and Clinical Characteristics of Patients

Socio-demographic characteristics of patients	Percentage of patients (%)
Mean (Standard deviation) Age, years	63.0 (10.8)
Language	
English	309 (44.6)
Chinese	350 (50.5)
Malay	34 (4.9)
Administration mode	
Self	111 (16.0)
Interviewer	538 (77.6)
By proxy	44 (6.4)
Gender	
Male	310 (44.5)
Female	386 (55.5)
Ethnicity	
Chinese	515 (73.8)
Malay	83 (11.9)
Indian	79 (11.3)
Other	21 (3.0)
Marital Status	
Single	57 (8.2)
Married	598 (85.7)
Others	43 (6.2)
Education Level	
No formal education	206 (29.7)
Primary	199 (28.7)
Secondary, Junior College, Pre-University, Institute of Technical Education	188 (27.1)
University, Polytechnic, Postgraduate	101 (14.6)
Type of Residence	
1 or 2 room	62 (9.0)
3 room	161 (23.2)
4 room	224 (32.3)
5 room or Executive Maisonette	183 (26.4)
Private properties	63 (9.1)
Occupational Status	
Retired	242 (34.7)
Employed	247 (35.4)
Unemployed	23 (3.3)
Housewife	172 (24.6)
Others	14 (2.0)

Table 1. Cont'd.

Socio-demographic characteristics of patients	Percentage of patients (%)
Monthly Household Income (Singapore Dollars)	
<\$1000	155 (22.4)
\$1000 – \$1999	102 (14.7)
\$2000 – \$3999	121 (17.5)
\$4000 – \$5999	50 (7.2)
>\$6000	51 (7.4)
Refuse to disclose/not sure	213 (30.8)
<b>Clinical characteristics of patients</b>	
<b>N (%)</b>	
Smoking	
Smoker	66 (9.5)
Never smoked	482 (69.3)
Ex-smoker	148 (21.3)
Duration of Diabetes	
<5	232 (33.4)
5-9	147 (21.2)
10-14	119 (17.1)
15-19	66 (9.5)
≥20	131 (18.9)
No. of visits to Doctor per year	
<4	95 (13.8)
4 (recommended)	455 (66.1)
>4	138 (20.1)
Diabetic Control: Diet	
Yes	581 (84.5)
No	107 (15.6)
Diabetic Control: Tablets	
Yes	637 (92.1)
No	55 (8.0)
Diabetic Control: Insulin	
Yes	74 (10.9)
No	608 (89.2)
Diabetic Control: Exercise	
Yes	424 (61.7)
No	263 (38.3)
Compliance to Medication	
All the time	502 (72.3)
Most of the time	111 (16.0)
Sometimes/Never	36 (5.2)
Not asked to take medication	45 (6.5)

Table 1. Cont'd.

Socio-demographic characteristics of patients	Percentage of patients (%)
Self Blood Sugar Monitoring at Home	
Yes	203 (29.3)
No	491 (70.8)
Complications: Stroke	
Yes	53 (7.6)
No	642 (92.4)
Complications: Ischaemic Heart Disease	
Yes	101 (14.6)
No	592 (85.4)
Complications: Kidney Disease	
Yes	53 (7.6)
No	641 (92.4)
Complications: Peripheral Neuropathy	
Yes	170 (24.5)
No	523 (75.5)
Complications: Eye Disease	
Yes	170 (24.6)
No	521 (75.4)
Complications: Peripheral Vascular Disease	
Yes	37 (5.4)
No	655 (94.7)
Number of Comorbidities	
0 or 1	201 (29.3)
2	246 (35.8)
≥3	240 (34.9)

and mortality. It has high prevalence and impact on the health of our population. Our study shows no association between health-related quality of life and glycaemic control as measured by HbA1c. This finding is consistent with many previous studies,<sup>9-11</sup> which also showed the lack of association of HbA1c with health-related quality of life. From this finding, we can understand why some patients do not perceive the benefits of good glycaemic control, because there is no obvious immediate improvement in quality of life when they do put in the effort to be compliant to medication and lifestyle. It is important for health practitioners to understand and address this because it may be the root of the global problem of non-adherence to treatment in the early phase for patients with type 2 diabetes mellitus in primary care.

SingHealth Polyclinics sees a large proportion of type 2 diabetic patients in primary care for secondary

prevention. These patients are often diagnosed early, before complications set in, when diabetes is still a silent disease, as many patients do not experience any symptoms. This is in contrast with hospital diabetic patients, whose disease progression is more severe, have more complications, and who require tertiary prevention. Hence in this unique population, it is vital to emphasise the need for good glycaemic control, which would impact on quality of life and outcome in the long run.

It is interesting that our finding differs from another local study done in the hospital setting.<sup>25</sup> In their study, HbA1c level of  $\geq 7\%$  was a significant negative predictor of health-related quality of life. It is important to know that we are possibly identifying a uniquely different population of patients in our study, and generating new understanding of type 2 diabetes mellitus patients seen in primary care, who are likely earlier in the course of the disease and with less complications. Our results suggest that health-related quality of life assessment is useful in the primary care setting in Singapore, as this cannot be estimated from HbA1c levels.

On the other hand, long-term poor glycaemic control, as reflected by presence of complications of diabetes including micro- and macro-vascular complications, appear to negatively affect health related quality of life. We do know that long-term poor glycaemic control does lead to increased diabetic complications and poor outcome. Hence, it is the responsibility of clinicians to reinforce to our patients the need for good control, even though the patient may not reap the benefits in the short term.

From our study, higher level of concern about diabetes was found to be associated with poorer mental well-being. This could be due to the higher level of anxiety and guilt about the patient's own medical condition, together with diet restriction, and pain from insulin injections and glucose monitoring. From a primary care perspective, it is very interesting that satisfaction with clinic and confidence in doctor were associated with better mental well-being. It is not clear, however, which is the cause and which is the effect as this was a cross-sectional study. Also, they may be mutually dependant on each other. Further studies on the components and factors affecting these 2 variables are necessary, to track which specific interventions lead to the concerns, and this should be taken into account when recommending treatment algorithms.

In Singapore which is a multi-ethnic country, we have seen that health-related quality of life is different across races, even after controlling for other factors. This is consistent with a previous local study on diabetic patients.<sup>15</sup> It is clear that ethnic differences do exist and can be clinically important. Also, the influence of ethnicity on health-related quality of life is complex, and socio-cultural influences may be the key to this difference.

Table 2. Quality of Life Scores by Socio-demographics, Clinical Treatment-related Variables, Complications and Comorbidities

Part A: Mean Quality of life scores by socio-demographics												
	PCS			MCS			EQ-5D Health Index			EQ-5D VAS		
	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P
<b>Language</b>			0.1137			0.4248			0.1410			0.6845
English	48.0	9.1		52.2	8.9		0.86	0.19		69.7	16.6	
Chinese	48.9	8.9		52.0	9.4		0.85	0.19		68.7	16.5	
Malay	45.9	9.2		50.0	11.0		0.80	0.27		69.9	17.7	
Others												
<b>Mode of Administration</b>			<0.0001			0.6867			<0.0001			<0.0001
Self	49.1	8.1		51.5	8.6		0.91	0.15		75.2	15.0	
Interviewer	48.9	8.6		52.1	9.2		0.85	0.19		68.3	16.7	
By proxy	39.5	11.2		51.1	11.3		0.71	0.30		64.9	16.2	
<b>Age</b>			<0.0001			0.921			<0.0001			0.180
50 and below	51.1	7.9		51.3	8.4		0.89	0.22		70.3	15.3	
51-60	50.2	7.2		52.0	9.9		0.89	0.15		70.1	16.4	
61-70	48.5	8.6		52.2	8.5		0.86	0.19		69.6	17.4	
More than 70	44.9	10.6		52.1	9.9		0.79	0.23		66.7	16.2	
<b>Gender</b>			<0.0001			0.214			<0.0001			0.151
Male	50.0	8.1		52.5	9.1		0.89	0.17		70.2	16.4	
Female	47.1	9.5		51.6	9.4		0.82	0.21		68.4	16.8	
<b>Race</b>			0.822			0.633			0.020			0.398
Chinese	48.5	8.9		52.2	9.1		0.86	0.18		69.2	16.4	
Malay	48.3	9.2		52.0	8.2		0.86	0.20		70.0	16.0	
Indian	47.7	9.0		50.7	11.2		0.79	0.25		66.8	17.6	
Others	47.2	10.0		52.1	8.7		0.85	0.22		73.1	18.5	
<b>Marital Status</b>			0.027			0.055			0.079			0.026
Single	49.1	8.7		49.2	12.0		0.85	0.18		63.6	16.7	
Married	48.6	8.9		52.3	8.7		0.86	0.20		69.8	16.6	
Others	44.9	9.3		51.8	11.7		0.79	0.22		68.3	15.4	
<b>Occupational Status</b>			<0.0001			0.0033			<0.0001			0.019
Employed	51.1	7.1		53.0	8.2		0.91	0.15		71.8	15.3	
Retired	47.6	9.1		52.4	9.2		0.85	0.20		67.7	17.4	
Unemployed*	46.9	9.1		47.6	13.3		0.79	0.25		65.9	17.7	
Housewife	45.9	10.2		51.0	9.4		0.80	0.22		68.2	16.6	
<b>Housing Types</b>			0.0903			0.0511			0.0044			0.017
HDB 1-3 room	47.6	9.5		50.8	10.0		0.82	0.21		66.6	16.9	
HDB 4-5 room	49.0	8.4		52.7	8.8		0.87	0.17		70.5	16.2	
Private†	47.3	9.7		51.9	9.4		0.84	0.25		70.3	16.8	
<b>Income</b>			<0.0001			0.005			0.0002			0.257
<\$1000	47.4	9.7		49.7	10.6		0.80	0.24		67.6	18.9	
\$1000-\$3999	48.8	8.4		52.3	8.9		0.86	0.20		69.1	15.5	
>\$4000	51.8	6.7		53.2	7.6		0.91	0.13		71.8	13.9	
Others (Refuse to disclose & don't know)	46.8	9.5		52.8	9.1		0.85	0.18		69.2	16.8	

\*and Others

†condo or landed

Table 2. Cont'd.

Part A: Mean Quality of life scores by socio-demographics												
	PCS			MCS			EQ-5D Health Index			EQ-5D VAS		
	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P
<b>Education Level</b>			<0.0001			0.2257			<0.0001			0.0009
No formal qualification	45.8	9.8		51.8	10.2		0.80	0.22		65.8	18.2	
Primary (PSLE)	48.2	9.1		51.2	9.0		0.84	0.21		68.7	15.9	
Secondary (O level/ N level/ITE/NTC)	50.2	7.2		53.1	8.1		0.90	0.16		71.9	15.3	
Tertiary (A level / Polytechnic/University)	50.5	8.3		51.8	9.7		0.91	0.13		71.9	15.9	
<b>Smoking</b>			0.072			0.338			0.092			0.046
Smoker	50.2	8.7		53.5	9.6		0.90	0.17		73.5	16.0	
Non smoker	47.9	9.1		51.7	9.4		0.84	0.20		68.3	16.8	
Ex-smoker	49.1	8.6		52.1	8.6		0.86	0.20		70.0	16.1	
Part B: Mean Quality of Life scores by clinical treatment-related variables												
	PCS			MCS			EQ-5D Health Index			EQ-5D VAS		
	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P
<b>Body Mass Index</b>			0.6587			0.074			0.3696			0.056
<18.5	50.3	8.0		46.6	14.2		0.79	0.33		62.7	18.8	
18.5-23	48.1	9.6		52.0	9.2		0.85	0.19		67.5	16.9	
≥ 23	48.5	8.7		52.1	9.1		0.86	0.19		70.2	16.1	
<b>Duration of Diabetes</b>			0.0174			0.930			0.003			0.3464
<5	49.6	8.1		52.1	9.2		0.88	0.18		70.4	17.1	
5-15	48.1	9.0		52.1	9.3		0.86	0.16		68.8	16.1	
>15	47.2	9.8		51.8	9.3		0.82	0.24		68.2	16.7	
<b>Visits to Doctor a Year</b>			0.084			0.568			0.028			0.448
<4	49.7	8.0		51.2	9.7		0.89	0.16		71.0	18.1	
4 (recommended)	48.4	9.1		52.2	9.3		0.86	0.19		69.2	16.3	
>4	47.1	9.3		51.6	9.0		0.82	0.22		68.2	16.1	
<b>Diabetic Control: Diet</b>			0.574			0.428			0.114			0.094
Yes	48.4	8.9		52.2	8.9		0.86	0.19		69.6	16.6	
No	47.9	9.4		51.3	11.0		0.83	0.21		66.7	16.6	
<b>Diabetic Control: Tablets</b>			0.0414			0.612			0.891			0.402
Yes	48.2	9.0		52.1	9.2		0.85	0.20		69.0	16.7	
No	50.7	7.5		51.4	10.0		0.86	0.18		71.0	15.8	
<b>Diabetic Control: Insulin</b>			0.0013			0.197			0.1318			0.617
Yes	44.5	10.7		50.8	10.3		0.81	0.24		68.3	17.2	
No	48.8	8.7		52.2	9.1		0.86	0.19		69.3	16.5	
<b>Diabetic Control: Exercise</b>			<0.0001			0.0724			<0.0001			0.010
Yes	50.3	7.7		52.6	8.5		0.88	0.16		70.6	16.5	
No	45.4	10.0		51.2	10.2		0.81	0.24		67.2	16.5	

Table 2. Cont'd.

Part B: Mean Quality of Life scores by clinical treatment-related variables												
	PCS			MCS			EQ-5D Health Index			EQ-5D VAS		
	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P
<b>Compliance to Medication</b>			0.009			0.291			0.152			0.833
All the time	47.6	9.3		52.2	9.3		0.85	0.21		68.9	16.7	
Most of the time	50.2	8.1		51.7	8.9		0.89	0.17		69.8	16.5	
Sometimes/Never	49.1	8.0		49.2	10.4		0.83	0.16		70.8	16.4	
Not asked to take medication	50.9	7.4		52.2	9.1		0.88	0.16		70.4	14.3	
<b>Self Blood Sugar Monitoring at Home</b>			0.0194			0.089			0.128			0.663
Yes	47.1	9.6		51.1	9.2		0.84	0.21		69.6	16.0	
No	48.8	8.7		52.4	9.3		0.86	0.19		69.0	16.9	
<b>Satisfaction with Clinic</b>			0.162			0.0006			0.121			<0.0001
None/A little	46.6	9.0		48.8	10.2		0.81	0.18		62.6	16.0	
Mostly	48.3	8.7		51.7	9.1		0.86	0.19		68.6	16.0	
Very	48.9	9.4		53.4	9.0		0.86	0.21		72.1	17.1	
<b>Confidence in Doctor</b>			0.861			0.003			0.563			0.068
None/A little	48.7	9.0		50.5	9.4		0.83	0.16		67.8	15.5	
Mostly	48.2	8.9		51.2	9.5		0.85	0.20		68.2	16.6	
Very	48.5	9.2		53.5	8.6		0.86	0.20		71.1	16.8	
<b>Level of Concern about Diabetes</b>			0.007			<0.0001			0.287			0.144
Not at all	49.6	8.5		54.3	7.8		0.87	0.19		71.0	16.9	
A little	49.3	8.6		52.2	8.5		0.87	0.21		69.8	16.3	
Quite	46.8	9.4		51.3	10.0		0.85	0.17		67.1	17.2	
Very	47.4	9.3		49.8	10.2		0.83	0.21		68.2	15.9	
Part C: Mean Quality of Life scores by complications and comorbidities												
	PCS			MCS			EQ-5D Health Index			EQ-5D VAS		
	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P
<b>Complications: Stroke</b>			0.003			0.068			0.007			0.375
Yes	43.8	11.2		54.2	8.7		0.74	0.31		67.2	15.2	
No	48.7	8.7		51.8	9.3		0.86	0.18		69.3	16.7	
<b>Complications: Ischaemic Heart Disease</b>			<0.0001			0.647			0.002			0.015
Yes	43.7	9.7		51.6	9.3		0.78	0.27		65.5	16.1	
No	49.1	8.6		52.1	9.2		0.87	0.18		69.8	16.6	
<b>Complications: Kidney Disease</b>			0.007			0.165			0.006			0.021
Yes	44.4	10.9		49.9	11.3		0.76	0.26		64.2	16.7	
No	48.7	8.7		52.2	9.1		0.86	0.19		69.6	16.5	
<b>Complications: Peripheral Neuropathy</b>			<0.0001			<0.0001			<0.0001			<0.0001
Yes	45.0	9.8		49.2	10.5		0.77	0.24		64.6	16.1	
No	49.4	8.4		52.9	8.6		0.88	0.17		70.6	16.5	



Table 2. Cont'd.

Part C: Mean Quality of Life scores by complications and comorbidities												
	PCS			MCS			EQ-5D Health Index			EQ-5D VAS		
	Mean	SD	P	Mean	SD	P	Mean	SD	P	Mean	SD	P
Complications: Eye disease			<0.0001			0.0008			<0.0001			<0.0001
Yes	44.8	9.9		49.6	11.4		0.76	0.24		64.9	17.3	
No	49.6	8.3		52.8	8.3		0.88	0.17		70.7	16.2	
Complications: Peripheral Vascular Disease			0.005			0.368			0.002			0.157
Yes	44.3	8.8		50.7	11.0		0.68	0.33		65.4	13.4	
No	48.6	8.9		52.1	9.2		0.86	0.18		69.4	16.7	
HbA1c			0.6381			0.2004			0.2726			0.2316
Ideal (4.6- 6.4%)	47.5	9.6		52.4	9.8		0.84	0.26		68.4	17.5	
Optimal (6.5- 7.0%)	49.1	9.2		51.8	9.6		0.86	0.19		68.8	17.0	
Sub-optimal (7.1- 8.0%)	48.4	8.9		52.8	8.3		0.87	0.17		70.9	15.8	
Unacceptable (>8.0%)	48.5	8.5		50.9	9.9		0.83	0.21		67.8	16.3	
Comorbidities			<0.0001			<0.0001			<0.0001			0.0006
0 to 1	51.3	7.1		53.2	7.9		0.91	0.16		72.3	17.1	
2	48.9	9.2		53.2	7.9		0.88	0.15		69.7	15.2	
3 to 7	45.4	9.3		50.0	10.9		0.77	0.23		66.3	17.2	

PCS: Physical Component Summary; MCS: Mental Component Summary; EQ-5D Health Index: EuroQol 5 Dimensions Health Index; EQ-5D VAS: EuroQol 5 Dimensions Visual Analogue Scale; PSLE: Primary School Leaving Examination; O/N/A Level: General Certificate of Education (Ordinary/Normal/Advanced) Level; ITE: Institute of Technical Education

In our study, exercise is associated with better physical and overall health while diet control is not. Health providers should advocate exercise for patients with type 2 diabetes mellitus, for the many benefits reaped including improved diabetic control, as well as higher health-related quality of life.

We recognise several limitations of this study. Firstly, this was a cross-sectional study which was only able to detect associations, but not causation. Longitudinal studies should be further carried out for this topic. All data were self-reported, hence the patients' medical conditions, complications, and comorbidities could be over or under-reported. Also, we do not have information on the control and severity of these conditions.

The strength of our study is the use of multiple quality of life measures. Since quality of life is multi-dimensional, a single global measure would not reveal how a factor affects patients' quality of life. In our study, we did find that physical functioning and well-being were associated with different set of variables. On the other hand, global measures such EQ-5D index and VAS scores quantify the overall quality of life and provide information about how much each factor contribute to the disease burden.

In conclusion, this study has shown that both socio-

demographic and clinical characteristics are important factors of health-related quality of life in type 2 diabetic patients treated in a primary care setting of Singapore. In particular, health-related quality of life is adversely associated with symptomatic complications of diabetes mellitus, but not with short-term diabetic control. This suggests that the diabetic patient may not appreciate the impact of good diabetic control immediately on his or her health-related quality of life. More effort should be invested into patient education of the importance of glycaemic control to prevent these long-term complications.

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Table 3. Summary of Multiple linear Regression Analysis

Variable (reference group)	Beta Coefficient (P value)			
	PCS	MCS	EQ-5D index	EQ-VAS
Administration mode				
Self-administered (interview)				4.2*
Proxy reported (interview)	-6.2‡		-0.10‡	
51 to 60 years old (>70 years old)	2.3*		0.05*	
Indian (Chinese)			-0.086‡	
Male			0.03*	
Single (married)				-5.6*
Medium income (low income)		1.9*		
High income (low income)	2.7*	2.8*		
Concern about diabetes				
Not concerned (very concerned)	2.4†	5.2‡		
Little concerned (very concerned)	2.0*	3.1†		
Quite concerned (very concerned)		2.1*		
Satisfaction with the clinic				
Not satisfied (very satisfied)		-2.8*		-7.7 ‡
Confidence in the doctor				
Mostly confident (very confident)		-2.2*		
Presence of comorbidities				
0 to 1 comorbidities (3+ comorbidities)	3.2‡	2.0*	0.09‡	
2 comorbidities (3+ comorbidities)	2.4†	2.4†	0.08‡	
Control diabetes by exercise	4.0‡		0.04†	
Complications of diabetes				
Stroke	-2.5*		-0.07*	
Ischaemic heart disease	-3.1‡		-0.05†	
Peripheral neuropathy disease	-2.6‡	-2.9‡	-0.05†	-3.3*
Eye disease			-0.04*	
Peripheral vascular disease			-0.08*	
R-square (adjusted)	28.3%	12.4%	25.7%	8.4%

\*  $P < 0.05$ , †  $P < 0.01$ , ‡  $P < 0.001$

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