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ORIGINAL ARTICLE

Beyond Glycaemia: Socioeconomic Factors and Diabetes Distress are Associated with Health-Related Quality of Life in People with Type 2 Diabetes

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Abstract

Background. Diabetes is a complex multifactorial disease. Therapy focused only on managing glycaemia does not yield optimal health outcomes. Health-related Quality of Life (HRQOL) is a broad, subjective, and multidimensional concept gaining significance in diabetes care. The complex interplay of HRQOL and other factors must be addressed to achieve optimal health outcomes.

Objective. We aim to describe the factors associated with HRQOL in type 2 diabetes.

Methodology. A single-center cross-sectional short messaging service (SMS) survey invited adults with type 2 diabetes (T2D) with ≥1 clinic attendance in the past year. Participants completed the Problem Areas in Diabetes-5 (PAID-5), Diabetes Distress Scale-17 (DDS17), and European Quality of Life Score (EQ-5D-5L). Demographic and diabetes-related data were retrieved from electronic medical records. Multiple regression models were created with EQ-5D-5L Index score (HRQOL) as the dependent variable.

Result. A total of 1406 people with T2D participated, 46.4% women, mean (SD) age 61.1 (13.4) years, BMI 27.1 (5.4) kg/m^2, and HbA1c 8.0 (1.4)%. Of these, 60.9% had ≥1 microvascular and 23.8% had ≥1 macrovascular complication. Mean (SD) of EQ-5D-5L Index score was 0.81 (0.27), EQ5D Visual Analog Score (VAS) was 77.4 (23.8), total mean DDS17 score was 1.87 (0.93) and PAID-5 score was 5.04 (4.5). 26.9% and 11.3% had significant diabetes distress (DD) based on PAID-5 ≥8 and DDS17 ≥3. Multiple regression models revealed diabetes distress, a lower class of housing type, presence of macrovascular complication, higher BMI, older age, and female sex to be associated with a poorer EQ-5D-5L Index Score.

Conclusion. Multiple non-glycemic factors like sociodemographic, socioeconomic, diabetes distress, impact health-related QoL in people with type 2 diabetes.

Key words: diabetes mellitus type 2, quality of life, mental health

INTRODUCTION

Quality of Life (QoL) is a broad, subjective, and multi-dimensional concept gaining importance in healthcare.[1] Dimensions of life like physical well-being, interpersonal relations, social, community, and civic activities, personal development, fulfilment and recreation affect QoL.[2] Health remains an important factor, as poor health has a ripple effect on multiple dimensions of life. Health-related QoL (HRQOL) is defined as aspects of the overall QoL that can be clearly shown to affect physical or mental health.[3] The impact of diabetes on HRQOL has gained greater significance due to the potential early onset and associated lifelong disease burden. The American Diabetes Association recommends that psychosocial care be provided for people with diabetes to optimise HRQOL.[4]

Diabetes affects HRQOL in multiple ways. For example, micro- and macrovascular complications of diabetes could impact physical well-being. Healthcare expenditure could impact the financial domain. Necessary self-care routines related to medications such as insulin administration may impact the freedom of spontaneity and interpersonal relationships. Mental health can be affected by diabetes

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distress (DD), depression, and the stigma of living with diabetes.[5] Diabetes distress refers to the emotional and cognitive stress of living with diabetes.[5] Individuals may feel overwhelmed by the demands of adhering to the recommended medications, diet and lifestyle. Diabetes distress is estimated to be prevalent in approximately 36% of people with T2D.[6] Further, diabetes distress affects self-care and self-efficacy.[7] People with high diabetes distress are less likely to engage in optimal self-care, resulting in poor glycaemia. In addition, depression and anxiety are associated with suboptimal glycaemia in young people with diabetes.[8] Diabetes distress has been associated with poor glycaemic control, increased diabetes complications, work productivity loss and all-cause mortality.[9–11] Fortunately, targeted intervention with cognitive behavioural therapy and mindful self-compassion have improved both glycaemic and psychological outcomes of people with DD.[12,13] Equally important is the environment in which a person lives, which significantly impacts their health and quality of life. Aspects of the environment, like the economic, environmental, political, and social conditions, are defined as Social determinants of health (SDOH).[14]

The definition of and the factors comprising SDOH have been described in various frameworks.[15] Factors working at a societal and national level could also influence health. However, for evaluation at the healthcare setting, socioeconomic position as defined by the World Health Organisation, includes factors such as social class, gender, ethnicity, education, occupation, and income, which can be readily assessed by the health care providers during the comprehensive evaluation of a person with diabetes.[15]

In summary, factors beyond glycaemia could affect the HRQOL of a person with diabetes. Socioeconomic factors, diabetes distress and perceived health status could all impact HRQOL. The ADA recommends routine screening for HRQOL, SDOH and diabetes distress in diabetes care. A better understanding of the complex dynamics will enable focused intervention to improve physical and psychosocial outcomes related to diabetes care. Our study aimed to describe the association between HRQOL, HbA1c and non-glycemic factors in people with type 2 diabetes in Singapore. We hypothesised that factors beyond glycaemia would be associated with HRQOL.

METHODOLOGY

This study was conducted at the SingHealth Duke-NUS Diabetes Centre, Singapore General Hospital. Singapore General Hospital is a tertiary care referral centre in Singapore. The data was collected from June 2021 to July 2021. SingHealth Institutional Review Board approved the waiver of informed consent for this research project (CIRB No: 2022/2616).

Study design

This was a cross-sectional observational study.

Study population

People with diabetes who attended the outpatient clinic at Singapore General Hospital.

Inclusion and exclusion criteria

Inclusion criteria

All people with diabetes who attended the clinic at least once in the past year (June 2020-May 2021) were invited.

Exclusion criteria

People with types of diabetes other than type 2 were excluded.

Study procedures

All eligible participants received a link via SMS, and they completed the following patient-reported outcome measures (PROM): Diabetes-Distress 17 (DDS17) score, Problem Areas in Diabetes (PAID) score, and European Quality of Life score – 5 dimensions – 5 levels (EQ-5D-5L). We used validated translations in English, Chinese, Malay, and Tamil. The participant could choose the preferred language.

Measures

We retrieved demographic and diabetes-related data from the Electronic Medical records (EMR). Demographic data were age, sex, ethnicity, BMI, and housing type. Housing type was used as a surrogate to determine socioeconomic status. Data from Singapore shows that the average monthly income per household member increases progressively across the housing classes: one/two/studio apartments, three-room, four-room, five-room/executive, condominium, non-landed, and landed houses.[16] Diabetes-related data collected were diabetes duration (year of diabetes diagnosis), type of glucose-lowering therapy (all prescribed medications), the presence of micro- and macrovascular complications, and HbA1c. All available diagnostic codes until the latest visit were retrieved. The presence of micro and macrovascular complications was discerned based on the relevant diagnostic codes. All data were extracted from the latest clinic visit.

We used two scales to measure DD in our study: the Diabetes Distress Scale (DDS17) and the Problem Areas in Diabetes (PAID-5) scale. The DDS17 is a 17-item questionnaire developed by Polonsky that studies diabetes distress over the preceding four weeks.[5] Each item is measured on a Likert scale of 1 (not a problem) to 6 (a very serious problem), and a total mean score is determined. Diabetes distress measured on DDS17 is divided into four subscales. These subscales are emotional distress (EB), regimen distress (RD), interpersonal distress (ID), and physician distress (PD). This provides a comprehensive assessment of diabetes distress. A total mean DDS17 score, calculated as the sum of all items divided by 17, ≥3 is considered significant.[5] PAID is a 20-item questionnaire, while the PAID-5 score

comprises five emotional-distress questions of the total PAID items (PAID-5, with items 3, 6, 12, 16, 19). The PAID-5 has satisfactory sensitivity (94%) and specificity (89%) for recognising diabetes-related emotional distress.[17] For the PAID-5 score, a score ≥5 indicates possible distress, and ≥8 indicates clinically significant diabetes-related emotional distress. Although the PAID-5 score was developed initially from Western (mainly European) populations with T2D, it has accepted validity in Asian populations (such as Korean people with diabetes).[18]

The European Quality of Life (EQoL) score, EQ-5D-5L, was used to measure HRQOL and is used for various diseases.[19] Respondents describe their HRQOL in 5 dimensions (EQ-5D descriptive system): mobility, self-care, usual activities, pain/discomfort, and anxiety/depression and rate across five levels (no problems, slight problems, moderate problems, severe problems, and extreme problems). Combining these scores provides a 5-dimensional and 5-level description of health status defined by a 5-digit number (EQ-5D self-reported health state, 11111 – best health state, 55555 – worst health state). EQ-5D utility value was derived from the 5L to 3L crosswalk of Singapore using the time-trade-off and crosswalk techniques.[20,21] The EQ-5D Index score represents the HRQOL for each participant, and it can range from 0 (dead) to 1 (full health). A value less than 0 indicates a state worse than death. The respondents also rate their overall health (Health Status) on a visual analog scale (EQ-VAS), between 0 (worst imaginable health) and 100 (best imaginable health). The EQ-VAS score depicts their perceived health status.

PROM data was anonymised and combined with sociodemographic and diabetes-related data from EMR. Data extraction and anonymisation were done by the Health Services Research Unit at Singapore General Hospital. The primary outcome was the association between HRQOL as assessed by EQ-5D Index score and other variables.

Sample size considerations

This study invited all people with diabetes who attended the clinic in the past year via an SMS link. Given the nature of this study, no sample size estimation was done.

Data analysis

All variables were screened for implausible values, and none were found. Data distribution was assessed using density plots and the Shapiro-Wilk test for normality. All univariate analysis results were expressed as mean (standard deviation, SD) for continuous variables as they were normally distributed and counts with percentages for categorical variables. A multiple linear regression model was built with EQ5D Index score as the dependent variable and socioeconomic and sociodemographic factors (age, gender, ethnicity, housing type, BMI), diabetes-related factors (HbA1c, diabetes duration, microvascular complication, macrovascular complication, insulin use), and diabetes distress (Model 1 = PAID-5, Model 2 = Total Mean DDS17 score) as independent variables. The presence of diabetic retinopathy, neuropathy or nephropathy was classified as a microvascular complication, and the presence of any atherosclerotic cardiovascular disease was classified as a macrovascular complication. The above variables were chosen based on the authors' consensus and current available literature suggesting that each of the above variables may have an impact on the quality of life for people with diabetes. Crude estimates from simple regression models for each predictor variable as well as adjusted estimates from multivariable models (with all variables included), are presented. Corresponding 95% confidence intervals were also presented. A two-sided p-value of less than 0.05 was considered to be statistically significant. As missing values were not replaced, complete case analyses were performed. Data manipulation and statistical analysis were done using Excel (Version 2302) and R (Version 4.3.1).

RESULTS

A total of 1406 with type 2 diabetes responded to the survey that was sent out to 6219 people. The response rate varied across the instruments (DDS17-737, 11.9%, PAID -769, 12.4%, EQ5D-5L -1008, 16.2%). The mean age of the cohort was 61.1(13.4) years, approximately half were female (46.4%). The predominant ethnicity was Chinese (67.1%), followed by Indian (16.9%) and Malay (12.3%). The average duration of diabetes in the study population was 16.2 (9.6) years, and the majority (74%) of the participants lived in public housing. The mean BMI was 27.1 (5.4) kg/m^2, and 55.2% were on insulin therapy. More than half (60.9%) of the participants had one or more microvascular complications, and 23.8% had one or more macrovascular complications. The mean HbA1c was 8.0 (1.4) %. The characteristics of the study population are shown in Table 1.

The mean (SD) of the EQ5D Index score adjusted for Singapore in this sample was 0.81(0.27). It ranged from -0.77 to 1, and the mean EQ-VAS score was 77.4 (23.8). An EQ5D Index score of 1 represents the HRQOL, and the EQ-VAS score of 100 represents the perceived health status, both corresponding to the best possible health state. A EQ5D Index Score less than 0 represents a state worse than death. The mean (SD) total mean DDS17 score for the whole cohort was 1.87 (0.93). Emotional distress subscale had the highest mean (SD) score [2.10 (1.09)], while physician distress had the lowest mean (SD) score [1.59 (1.13)]. The mean (SD) PAID-5 score was 5.04 (4.5). The proportions with clinically significant diabetes distress defined by the DDS17 total mean Score ≥3 and a PAID-5 score ≥8 was 11.3% and 26.9%, respectively (Table 2). About half of the participants (46.9%) described a perfect health state depicted by "11111" and only one participant (0.1%) described the worst health state depicted by "55555." The proportions for health states in between are shown in Table 3.

In the analyses using simple linear regression, housing type had the highest association with HRQOL. Living in a non-

Table 1. Participant characteristics

Characteristic	Type 2 (N = 1406)
Age, years, mean (SD)	61.1 (13.4)
Sex	
Female, n (%)	653 (46.4%)
Male, n (%)	753 (53.6%)
Ethnicity	
Chinese	932 (67.1%)
Malay	171 (12.3%)
Indian	235 (16.9%)
Others	51 (3.7%)
Housing	
One-room/two-room/studio	53 (4.0%)
Three room	212 (16.0%)
Four room	362 (27.4%)
Five/exec	352 (26.6%)
Condo non-landed	192 (14.5%)
Landed	150 (11.4%)
Unknown	85
BMI, kg/m², mean (SD)	27.1 (5.4)
Diabetes Duration, years, mean (SD)	16.2 (9.6)
Type of Glucose lowering treatment	
Oral with sulfonylureas	292 (22.2%)
Oral without sulfonylureas	298 (22.6%)
Insulin premixed	230 (17.5%)
Insulin basal only	160 (12.2%)
Insulin basal bolus	269 (20.4%)
Insulin bolus only	67 (5.1%)
Unknown	90
Microvascular complications, any	856 (60.9%)
Nephropathy	694 (49.4%)
Retinopathy	346 (24.6%)
Neuropathy	70 (5.0%)
Macrovascular complications, any	335 (23.8%)
Ischemic heart disease	274 (19.5%)
Cerebrovascular disease	52 (3.7%)
Peripheral vascular disease	50 (3.6%)
HbA1c (%), mean (SD)	8.0 (1.4)
HbA1c (mmol/mol), mean	64

BMI – Body Mass Index

Table 2. Patient-reported outcome measures

Patient-reported outcome measure	Type 2 diabetes
EQ-5D-5L	Mean (SD) (N=879)
EQ-VAS health status score	77.4 (23.8)
EQ5D 5L index score	0.81 (0.27)
Anxiety/depression	1.33 (0.64)
Mobility	1.34 (0.73)
Self-care	1.13 (0.53)
Usual activities	1.27 (0.68)
Pain	1.58 (0.76)
Diabetes Distress Score (DDS 17)	Mean (SD) (N=637)
Total mean score	1.87 (0.93)
Physician distress subscale mean score	1.59 (1.13)
Emotional distress subscale mean score	2.10 (1.09)
Regimen distress subscale mean score	1.99 (1.07)
Interpersonal distress subscale mean score	1.65 (1)
Proportion with total score ≥3	72 (11.3%)
PAID-5 score	Mean (SD) (N=676)
Total Score	5.04 (4.5)
Proportion with total score ≥8	182 (26.9%)

EQ-5D-5L – European Quality of Life 5 Dimension 5 Level, VAS – Visual Analog Score, PAID – Problem Areas in Diabetes

Table 3. EQ-5D health states

Health states (n = 879)	Frequency (%)	Cumulative frequency (%)
11111	412 (46.9)	46.9
11112	116 (13.2)	60.1
11122	39 (4.4)	64.5
11121	35 (4)	68.5
21112	35 (4)	72.5
21212	15 (1.7)	74.2
11123	10 (1.1)	75.3
21111	10 (1.1)	76.5
21122	10 (1.1)	77.6
11212	9 (1)	78.6
21222	8 (0.9)	79.5
11132	7 (0.8)	80.3
11222	7 (0.8)	81.1
21213	5 (0.6)	81.7
21223	5 (0.6)	82.3
22222	5 (0.6)	82.8
.....		
55555	1 (0.1)	100.0

landed condominium was associated with a higher HRQOL (Crude β, [95% CI] = 0.17 [0.07 – 0.27]) compared to living in a one/two/studio apartment. Other variables associated with a lower HRQOL found in simple linear regression were the presence of macrovascular complications, Indian ethnicity compared to Chinese ethnicity, insulin use, presence of microvascular complications, female sex, a higher PAID score, longer diabetes duration, higher BMI, and older age, in decreasing strengths of association. The total mean DDS score and HbA1c did not show any significant association with HRQOL in simple linear regression. Multiple linear regression models with HRQOL defined by EQ5D Index score as the dependent variable were generated. In a fully adjusted model with the PAID score for diabetes distress, only a lower class of housing type, a higher BMI, presence of macrovascular complication, higher PAID score, and older age remained significantly associated with lower HRQOL. In the fully adjusted model with total mean DDS score for diabetes distress, it was shown that the female sex, a lower class of housing type, lower HbA1c, higher BMI and presence of macrovascular complications were significantly associated with a lower HRQOL (Table 4).

DISCUSSION

This study found that HRQOL in people with type 2 diabetes is associated with multiple nonglycemic factors. Diabetes distress as described by PAID score, living in a lower class of housing type, older age, female sex, higher BMI, and the presence of macrovascular complications were associated with lower HRQOL.

Our findings are largely concordant with published data on HRQOL in diabetes. Our mean (SD) EQ-5D-5L index score of 0.81 is the same as the finding of 0.81 (95% CI: 0.81-0.82) for people with T2D in a meta-analysis of nine studies using EQ-5D-5L.[22] It also falls within the range of 0.78 to 1.00 found in people with T2D in East and Southeast Asian countries.[23] Our mean EQ-VAS score of 77.4 is slightly higher than the upper bound of its range from 72.3 to 76.3 for people with T2D but without complications.[23] Thus, the

HRQOL of the participants in this study sample is very typical of people with T2D in the general population.

A recent systematic review summarised all the cross-sectional studies between 2012 and 2022 on adults with T2D investigating the factors associated with HRQOL.[24] Eight different instruments were used across 35 studies on HRQOL in diabetes. The review found various factors like sociodemographic factors (age, marital status, gender, monthly income, education, area of residence, and religiosity), person-centered factors (diabetes knowledge and self-efficacy), disease characteristics (HbA1c, comorbidities, duration of diabetes and insulin treatment), self-management behaviors (physical activity, medication adherence, and frequent glucose checks) and family support to be predictors of HRQOL.[24] More specifically, multiple studies have reported a lower HRQOL in females with diabetes compared to males.[25–27] This could be due to multiple factors like a higher propensity for mental health disorders in females, differences in financial status, and their reduced sense of control over life circumstances.[28] Studies from Indonesia and Malaysia found that DD was associated with poorer HRQOL, similar to our findings.[29–31] A high BMI has also been reported to have a negative effect on HRQOL.[32]

A higher HbA1c is associated with a lower HRQOL in prior studies.[24] A possible reason for the lower HRQOL with a higher HbA1c is the perceived worse diabetes disease state and fear of complications triggered by a higher HbA1c result. This could have a couple of implications. Firstly, studies show that many people with T2D forget their recent HbA1c. Hence, the timing of the administration of a PROM survey may affect its relationship with HbA1c. Our study did not administer the PROM questionnaires during a clinic visit. Instead, all eligible participants received an SMS one day, irrespective of their upcoming appointments. This could be a reason for the lack of a relationship between HbA1c and HRQOL, even in simple regression. Secondly, the type of diabetes distress scale included in a regression model could modify the impact of HbA1c on HRQOL. For example, the PAID-5 scale has 2/5 items related to diabetes complications, which could reduce the effect of HbA1c on HRQOL when the PAID-5 scale is included as an independent variable. However, DDS17 has only 1/17 items directly related to diabetes complications. Prior studies from Singapore in the primary care setting reported that higher HbA1c, a higher DD, and younger age were associated with lower HRQOL.[33] However, when fully adjusted with diabetes distress (PAID) and other variables, no association existed between HbA1c and EQ-5D-5L Index score, similar to our findings.[34] In Model 2 using DDS17,

Table 4. Simple and multiple linear regressions of factors associated with EQ-5D-5L scores

	Simple linear regression (Crude estimates)			Multiple linear regression Model 1: PAID-5 Score [Adjusted]			Multiple linear regression Model 2: Total DDS17 Score		
Adjusted R²				0.176			0.125		
p-value				<0.001			<0.001		
Characteristic	**Beta**	**SE[1]**	***p*-value[2]**	**Beta**	**SE[1]**	***p*-value[2]**	**Beta**	**SE[1]**	***p*-value[2]**
PAID-5 Score	-0.02	0.00	<0.01***	-0.02	0.00	<0.01***			
Total Mean DDS Score	-0.01	0.02	0.5				-0.02	0.00	>0.9
Age	0.00	0.00	<0.01***	0.00	0.00	<0.01**	-0.00	0.00	0.02*
Male	—	—		—	—		—	—	
Female	-0.05	0.02	<0.01**	-0.04	0.02	0.06	-0.09	0.03	<0.01**
Ethnicity									
Chinese	—	—		—	—		—	—	
Indian	-0.08	0.03	<0.01**	-0.04	0.03	0.15	-0.07	0.04	0.08
Malay	-0.04	0.03	0.11	0.04	0.03	0.2	-0.05	0.05	0.4
Others	0.03	0.05	0.6	0.02	0.06	0.8	-0.00	0.09	>0.9
Housing Type									
One/Two/Studio	—	—		—	—		—	—	
Three Room	0.07	0.05	0.13	0.08	0.05	0.12	0.30	0.08	<0.01**
Four Room	0.14	0.05	<0.01**	0.13	0.05	<0.01**	0.35	0.08	<0.01***
Five/Executive	0.12	0.05	<0.01**	0.12	0.05	0.01*	0.31	0.08	<0.01***
Condo non-landed	0.17	0.05	<0.01***	0.15	0.05	<0.01**	0.35	0.09	<0.01***
Landed	0.14	0.05	<0.01**	0.13	0.06	0.02*	0.38	0.09	<0.01***
BMI	0.00	0.00	0.03*	-0.01	0.00	<0.01**	-0.01	0.00	0.02*
HbA1c	-0.01	0.01	0.3	0.01	0.01	0.2	0.02	0.01	0.03*
Diabetes duration	0.00	0.00	<0.01***	0.00	0.00	0.08	-0.00	0.00	0.3
Microvascular complication									
No	—	—		—	—		—	—	
Yes	-0.06	0.02	<0.01**	-0.02	0.02	0.5	0.00	0.04	>0.9
Macrovascular complication									
No	—	—		—	—		—	—	
Yes	-0.10	0.02	<0.01***	-0.06	0.03	0.03*	-0.09	0.04	0.04*
Insulin Use									
No	—	—		—	—		—	—	
Yes	-0.08	0.02	<0.01***	-0.01	0.02	0.6	-0.03	0.04	0.4

[1]SE = Standard Error, [2]*p<0.05; **p<0.01; ***p<0.001. DDS- Diabetes Distress Scale, PAID- Problem Areas in Diabetes, BMI- Body Mass Index

we found a weak positive association between HbA1c and HRQOL (i.e., a higher HbA1c improves HRQOL). We are unable to explain this discordant finding in Model 2.

The presence of macrovascular complications was consistently associated with a lower HRQOL. This was expected as, in clinical practice, people with cardiovascular complications like myocardial infarction or stroke are more concerned about health implications compared to those with microvascular complications like neuropathy, retinopathy, or nephropathy. The acute nature of the presentation of macrovascular complications with immediate life-changing consequences versus the insidious onset and slow progression of microvascular complications may explain this.

Diabetes distress was a significant factor associated with HRQOL. Diabetes is a chronic condition with multifactorial aetiology and drivers. Despite the emergence of newer classes of medications, achieving optimal glycaemia to limit diabetes-related complications is still elusive, with only about half achieving an HbA1c of <7%.[35] Treatment success in diabetes requires the right medication and adherence to medication, lifestyle changes, and observation of several diabetes self-care habits. The psychological burden of living with diabetes, diabetes distress, has a bidirectional impact on diabetes.[36] Studies have shown that diabetes distress is associated with anxiety, depression, and reduced self-efficacy, which leads to poor self-care, lower HRQOL, and, ultimately, a vicious cycle leading to poor glycaemia and diabetes-related complications.[36] Prior studies from Singapore have shown a high prevalence of severe diabetes distress (31.4%, using a PAID score >40) in the primary care setting.[37] Similarly, our study found a prevalence of 26.9% for significant diabetes distress (PAID-5 ≥8). Interestingly, significant DD, as assessed by DDS17 (Total mean score ≥3), was lower at only 11.3%. Although both PAID and DDS17 are reliable instruments, there are significant differences. PAID covers more emotional concerns and is related to coping styles; hence, it correlates better with HRQOL. DDS17, instead, is more related to aspects of diabetes treatment, motivational and behavioural aspects, and, therefore, has a better correlation to metabolic outcomes.[38] Our findings were concordant with this in that only PAID-5 was significantly associated with HRQOL and not DDS17. PAID-5 may be a better determinant for identifying the emotional burden and QoL in people with T2D.

Socioeconomic status is well recognised as a determinant of health. Although Singapore is a developed country, income disparity and relative poverty are prevalent based on the OECD's (Organization for Economic Cooperation and Development) definition of relative poverty.[39] In Singapore, healthcare is not free but subsidised according to 'means testing'. The principle of means testing is to provide a higher degree of financial subsidy for those in the lower economic strata, thereby attempting to reduce the financial inequity in healthcare.[40] The Ministry of Health further refined means testing by changing the assessment parameter from average individual monthly income to per capita household income, as per capita household income would better represent the financial burden in situations where all family members may not be earning.[40] Further, the Agency of Care Effectiveness (ACE),[41] established in 2015, aims to improve the access of Singaporeans to clinically effective medicines and medical technology. This agency has played a vital role by conducting health technology assessments on medications' clinical effectiveness and cost-effectiveness, informing subsidy decisions, and fixing value-based pricing for clinically effective drugs and technologies.[42] However, despite these existent measures, our data shows that the type of housing, a surrogate measure of average monthly income,[16] was a significant factor associated with poorer HRQOL of people with diabetes in Singapore. Since all healthcare expenditure is "out-of-pocket" in Singapore, the economic impact of diabetes could be significant, especially for those in the lower socioeconomic strata, with potential financial implications even to aspects of QOL beyond health. The economic burden could also directly impact health via medication nonadherence. Medication nonadherence among newly diagnosed people with diabetes in Singapore has been reported to be as high as 35%.[43] Studies have shown that the most common reason for medication nonadherence is cost-related.[44] This is consistent with data that socioeconomic factors may have a high impact on health outcomes, even higher than self-care behaviours and clinical care.[45]

Non-glycemic factors as discussed above significantly impact HRQOL. A lower HRQOL leads to lower self-efficacy and suboptimal self-care. It becomes imperative that healthcare providers address these factors in all people with diabetes.[4] Socioeconomic and sociodemographic factors and diabetes distress, if left unaddressed, could have a significant stalling effect on diabetes care. Hence, clinicians must periodically assess these aspects. Apart from optimising the medications according to the risk profile of a person with T2D, optimising their psychosocial care must also become a priority. Short, validated instruments like DDS2 and PAID-5 serve as quick screening tools during consults, with the administration of more comprehensive tools reserved for those with suspected diabetes distress.[46]

Once identified, the management of diabetes distress depends on individual needs. For example, education on diabetes may allay irrational fears about complications, instruction on skills required to manage diabetes may reduce the burden of self-care, and introducing technology could reduce diabetes-specific burdens like glucose monitoring and insulin injections. For more complex situations, cognitive behavioural therapy, mindfulness therapy, and motivational interviewing techniques administered by a trained healthcare professional or diabetes psychologist have improved psychological and metabolic outcomes.[47] Addressing the unfavourable socioeconomic factors is equally crucial in enhancing diabetes health outcomes. Social prescribing is an intervention to improve well-being by linking individuals to community assets to optimise

their health.[48] It moves beyond the biomedical model of diabetes care to involve non-medical community resources and interventions to address the social factors.[49] Social prescribing needs to be improved and integrated with diabetes care in Singapore to educate and empower healthcare providers tackling complex multifactorial conditions like type 2 diabetes.

The strengths of our study include the relatively large number of people who participated in the survey. However, the response rates for our SMS survey were relatively low. Nevertheless, the demographic data of our participants was comparable to unpublished data from the SingHealth diabetes registry.[35] People with type 2 diabetes consulting at Singapore General Hospital have a mean age of 63.4 years, 48.1% are female, and have an ethnicity distribution of 68.7% Chinese, 12% Malays, 15.1% Indians and 4.2% other ethnicities. This is comparable to the demographic features of our study participants, suggesting representativeness from a sociodemographic perspective. We also retrieved relevant factors from the SingHealth Diabetes Registry to study their association with HRQOL. The limitations of our study include the fact that there were missing data among the instruments administered. We did not have measures of self-efficacy or diabetes self-management, which were both identified in prior studies as important parameters. We used only the diagnostic codes to determine diabetes complications; hence, the reported complication rates are likely underestimated. The proportion of insulin users was higher in this cohort than in the whole cohort of people with type 2 diabetes in Singapore General Hospital (31.7%, unpublished data). Furthermore, as stated earlier, the response rate to the SMS survey was also relatively low; hence, any generalisation of study findings must be cautious. Timing the SMS survey before or during a clinic visit might improve response rates in future studies. This cohort may not be representative of people with type 2 diabetes in primary care.

CONCLUSION

Factors beyond glycaemia, like socioeconomic and sociodemographic factors, and diabetes distress, are significantly associated with health-related quality of life in people with T2D.

Statement of Authorship
All authors certified fulfillment of ICMJE authorship criteria.

CRediT Author Statement
SRC: Conceptualization, Methodology, Software, Validation, Formal Analysis, Investigation, Resources, Data curation, Writing – original draft preparation, Writing – review and editing, visualisation, Supervision, Project administration. **GSKK:** Methodology, Software, Validation, Formal Analysis, Resources, Data curation, Writing – original draft preparation, Writing – review and editing, visualisation. **NNBMS:** Software, Validation, Formal Analysis, Resources, Data curation, Writing – review and editing, visualisation. **XX:** Conceptualization, Methodology, Formal Analysis, Resources, Writing – review and editing, visualisation. **GHL:** Conceptualisation, Methodology, Formal Analysis, Resources, Writing – review and editing, visualisation. **DG:** Investigation, Resources, Writing – review and editing, visualisation. **SG:** Conceptualization, Methodology, Investigation, Resources, Data curation, Writing – review and editing, visualisation, Supervision, Project administration, Funding acquisition.

Data Availability Statement
Datasets are not publicly available because participants in the study did not give written consent for their data to be shared.

Author Disclosure
The authors declared no conflict of interest.

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