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Health-related quality of life of type 2 diabetes patients hospitalized for a diabetes-related complication

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Abstract

Purpose To estimate the health-related quality of life (HRQoL) of type 2 diabetes (T2DM) inpatients hospitalized for a complication in China and to explore the associated factors.

Methods This was a cross-sectional study. T2DM inpatients (aged ≥ 18 years) hospitalized for a complication, including ischemic heart disease (IHD), acute myocardial infarction (AMI), congestive heart failure (CHF), stroke, impaired vision, end-stage renal disease (ESRD), ulcer, and amputation were recruited from a tertiary hospital in China from January to May 2017. The EuroQoL-5 dimensions were used to measure HRQoL. A one-way analysis of variance and a multivariate regression analysis were performed.

Results Eight hundred and two T2DM inpatients hospitalized for a complication were included. The mean age was 62.67 years, and 43% of the inpatients were female. The mean utility-based HRQoL was 0.562 (95% CI 0.548, 0.577). The utility varied significantly between the complications: IHD = 0.620 (95% CI 0.597, 0.642), AMI = 0.434 (95% CI 0.394, 0.473), CHF = 0.471 (95% CI 0.433, 0.510), stroke = 0.472 (95% CI 0.436, 0.508), impaired vision = 0.714 (95% CI 0.692, 0.737), ESRD = 0.693 (95% CI 0.670, 0.717), ulcer = 0.431 (95% CI 0.375, 0.487), and amputation = 0.395 (95% CI 0.341, 0.448). Inpatients with a complication, who were female, and who had no daily exercise had a lower HRQoL.

Conclusions The HRQoL of T2DM inpatients with a complication was considerably impaired. Our estimates provide supplementary data for public health and cost-effectiveness modeling, and increase the breadth of knowledge of HRQoL in T2DM.

Keywords Health-related quality of life · Utility · EQ-5D · Type 2 diabetes · Inpatient · Diabetes-related complication

Introduction

Diabetes imposes a considerable disease burden on patients and the healthcare system in China. Its prevalence was 10.9% among adults in 2017 [1]. China has the world's largest diabetes epidemic (114.4 million), which accounts for 26.9% of the global diabetic population [1]. Type 2 diabetes (T2DM) accounts for approximately 90% of all diabetes cases [2]. Long-term poor management can lead to life-threatening chronic complications, including stroke, myocardial infarction, heart failure, kidney failure, blindness, and diabetic foot. These complications have quite high incidences and result in frequent hospitalizations and early death [1]. Approximately 46% of Chinese T2DM outpatients have a history of microvascular complications, 15% have cardiovascular disease, and 10% have cerebrovascular disease [3]. T2DM and its complications resulted in 843,000 deaths in 2017. The resulting healthcare expenditures were

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US$ 63.095 billion, ranking second only to the United States globally [1]. The medical costs and healthcare utilization of T2DM inpatients with new-onset chronic complications are generally higher than those of outpatients with preexisting complications in China [4].

T2DM and its complications not only increase patients' mortality and healthcare costs but also impair their health-related quality of life (HRQoL) [1, 5–8]. HRQoL is a multidimensional concept that reflects a patient's physical, psychological, social, and emotional well-being [9]. It is a widely recognized measure that estimates the effect of chronic diseases on health [10] and is related to increased mortality and healthcare utilization [11, 12]. A HRQoL assessment in T2DM patients provides a comprehensive evaluation of a patient's health status, which could provide information that supplements laboratory data and subjective symptoms, and allows for more personalized clinical decisions in T2DM care [13, 14]. The evidence shows that T2DM patients have a lower HRQoL than those without diabetes in the same age group, and that HRQoL continues to reduce with disease aggravation and complications [15–18]. Impairment in HRQoL is linked to the severity of the complications [19]. Reliable estimates of the impact of T2DM and its complications on HRQoL at different disease severity are important to understand the full disease burden. Additionally, utility estimates are essential input parameters for measuring quality-adjusted life years (QALYs) in economic evaluations. To have a complete and valid model, when simulating the impact of chronic complications, it is necessary to identify both the QALYs during hospitalization and the long-term maintenance QALYs after discharge.

However, previous studies estimating the HRQoL associated with diabetic complications have primarily focused on T2DM outpatients with a history of complications or with preexisting complications, whose symptoms may be less severe [8, 14, 20–22]. Little is known about how a complication during hospitalization with more severe symptoms may relate to HRQoL [19]. Instruments used for measuring HRQoL have varied across studies, and not all of the studies reported utility values. The utility estimates may vary depending on multiple factors such as population, disease severity, instrument and tariff used [23]. Therefore, it is better to use a consistent instrument to evaluate the utility-based HRQoL of T2DM patients from different populations and disease severity to use in cost-effectiveness analyses and to allow comparability across studies. The EuroQoL-5 dimension (EQ-5D) is a utility instrument measuring HRQoL. It is recommended for use in cost-effectiveness analyses by institutions such as the National Institute for Health and Care Excellence, and it has been extensively recognized and used worldwide [20].

Therefore, this study aimed to estimate the utility-based HRQoL of T2DM inpatients in China who were hospitalized for a major chronic complication by using the EQ-5D and to explore the factors associated with HRQoL. This research may provide a valuable supplement to previous studies.

Methods

Study design and participants

This was a cross-sectional study. The study was reviewed and approved by the Medical Faculty Ethics Committee of Zhejiang University. The information collected from all of the participants was kept confidential and anonymous. T2DM inpatients being hospitalized for a diabetes-related complication were recruited from a tertiary hospital in Shandong, China, from January to May 2017. The eligibility criteria included the following: (1) patients aged 18 years and older; (2) patients with a physician diagnosis of T2DM; (3) patients who were not pregnant; (4) patients who were conscious, had no cognitive impairment or mental illness, and could express themselves clearly; (5) patients who were hospitalized for a chronic complication. The complications that were identified were from the United Kingdom Prospective Diabetes Study (UKPDS) [24] and included ischemic heart disease (IHD), acute myocardial infarction (AMI), congestive heart failure (CHF), stroke, impaired vision, end-stage renal disease (ESRD), ulcer, and amputation, which are all major complications leading to hospitalization [1]. Definitions of the complications are shown in Table S1.

Instruments and variable description

The survey was conducted using a self-designed questionnaire, based on a literature review and expert consultation, and was modified based on a pilot study. Two categories of variables were included as follows: participant characteristics and EQ-5D instrument.

The participant characteristics included sociodemographic and clinical variables. The sociodemographic variables included gender, age, marital status, education level, employment status, and annual household income. Age was categorized into three groups: <45 years, 45–64 years, and ≥ 65 years. Marital status was divided into single (i.e., not married or not living in a partnership) and not single (i.e., married or living in a partnership). Education level was classified as junior high school or below, senior high school, and undergraduate or over. Employment status was categorized as unemployed, employed, and retired. Annual household income was divided into $<$¥20,000, ¥20,000~, ¥40,000~, ¥60,000~, ¥80,000~, and $\geq$¥150,000. The clinical variables included the complications (i.e., IHD, AMI, CHF, stroke, impaired vision, ESRD, ulcer, and amputation), body mass index (BMI), duration of diabetes, hypertension,

dyslipidemia, current smoker, current alcohol drinker, and exercise. BMI was recorded as and calculated from the patients' height and weight, which were identified from their medical records. The 'criteria of weight for adults' published by the National Health Commission of China defined weight categories as underweight (BMI < 18.5 kg/m^2), normal weight (18.5 ≤ BMI < 24 kg/m^2), overweight (24 ≤ BMI < 28 kg/m^2) and obese (BMI ≥ 28 kg/m^2) [25]. Therefore, BMI was divided into four categories. Binary variables were presented for hypertension, dyslipidemia, current smoker and current alcohol drinker (yes vs. no). A current smoker was defined as someone who had smoked 100 cigarettes in their lifetime and currently smoked cigarettes. A current alcohol drinker was defined as someone who had alcohol intake more than once per month during the past 12 months [26]. Exercise was grouped as had no daily exercise, had exercise of < 2 h daily, and had exercise of ≥ 2 h daily.

The EQ-5D-3L instrument (a simplified Chinese version for China) was used to measure HRQoL. The instrument consists of a health state descriptive system and a visual analogue scale (VAS). The descriptive system comprises five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each of the dimensions has three responses: no problem, some problem, and extreme problem. The responses to the five dimensions were converted into an EQ-5D utility score using a Chinese population-based EQ-5D-3L social value set [27]. In the VAS part, participants marked their health on a scale ranging from 0 (worst imaginable health state) to 100 (best imaginable health state).

Data collection

Face-to-face interviews were conducted. First, the investigators checked the patient's medical records and laboratory test records to confirm the diagnosis of T2DM and the main complication that had led to the hospital admission and selected the eligible inpatients with the assistance of the doctors. The main diagnosis on the medical records was regarded as the criterion for judging the main complication. Although some of the inpatients might have a history of more than one complication that was not the main reason for this hospitalization, we only considered the main complication after discussions with the doctors. Second, accompanied by the nurses, the investigators contacted the inpatients in the ward immediately after they were selected and explained the purpose and process of the study to them. Those who agreed to participate in the survey filled out an informed consent and the study questionnaire by themselves. For inpatients who were illiterate or had impaired vision, the investigators were available to provide assistance if necessary while taking care to avoid any influence on the patients' responses. The investigators were trained to fully understand the purpose and processes of the survey and to master the skills and precautions in the survey. They also checked to make sure the questionnaire was complete when a patient was finished.

Statistical analysis

The characteristics and HRQoL of T2DM inpatients were summarized using descriptive statistics. The mean and 95% confidence interval (CI) were calculated for continuous variables. Both a number and percentage were calculated for categorical variables. A one-way analysis of variance test was used to compare the inpatients' EQ-5D utility and EQ-VAS score according to their characteristics. A Pearson correlation test was conducted to check the correlation between EQ-5D utility and EQ-VAS score by complication. A Tobit regression model was used to determine the factors that were significantly associated with EQ-5D utility and EQ-VAS score. The Tobit model was chosen because the distributions of EQ-5D utility and EQ-VAS are skewed, and the utility score is censored at 1 and the VAS score is censored at 100 [24, 28, 29]. Independent variables were chosen based on previous studies, which included gender, age, marital status, education level, employment status, complication, BMI, hypertension, dyslipidemia, current smoker, current alcohol drinker, and exercise [6, 7, 30–33]. A $p < 0.05$ was considered statistically significant. The data were double entered and checked by EpiData 3.1 and analyzed with Stata/SE 15.1.

Results

Participant characteristics

A total of 840 T2DM inpatients were selected. Eight hundred and two inpatients agreed to participate in the survey. There were 175 inpatients with IHD, 112 with AMI, 88 with CHF, 153 with stroke, 114 with impaired vision, 115 with ESRD, 35 with ulcer, and 10 with amputation. The mean age was 62.67 (95% CI 61.89, 63.45) years, with a female proportion of 43%. More than half of the inpatients (59.6%) had an education level of only junior high school or below, and 63.1% were retired. Most of them (86.3%) were married or living in a partnership. The average BMI was 24.98 (95% CI 24.72, 25.23) kg/m^2, and 60% of the inpatients were overweight or obese. Only 461 inpatients (57.5%) knew the duration of their diabetes, and reported a mean duration of 11.78 (95% CI 10.99, 12.56) years. Nearly 67% of the inpatients reported comorbid hypertension, and 39.7% reported comorbid dyslipidemia (Table 1).

Table 1 Characteristics of type 2 diabetes inpatients, and EQ-5D utility and EQ-VAS score stratified by their characteristics

Variables	*N* (%)	EQ-5D utility score			EQ-VAS score		
		Mean	95% CI	*p*	Mean	95% CI	*p*
Gender				0.071			0.172
Male	457 (57.0)	0.574	[0.555, 0.593]		62.44	[60.85, 64.03]	
Female	345 (43.0)	0.547	[0.525, 0.569]		60.77	[58.99, 62.55]	
Age (years)				< 0.001			0.049
< 45	53 (6.6)	0.636	[0.584, 0.689]		66.79	[62.80, 70.79]	
45–64	377 (47.0)	0.586	[0.567, 0.605]		62.00	[60.32, 63.69]	
≥ 65	372 (46.4)	0.527	[0.505, 0.550]		60.71	[58.90, 62.53]	
Marital status[a]				0.083			0.593
Single	110 (13.7)	0.530	[0.491, 0.570]		60.91	[57.57, 64.25]	
Not single	692 (86.3)	0.567	[0.552, 0.583]		61.85	[60.58, 63.12]	
Education level				0.004			0.026
Junior high school or below	478 (59.6)	0.543	[0.524, 0.561]		60.38	[58.78, 61.97]	
Senior high school	207 (25.8)	0.587	[0.560, 0.615]		63.65	[61.44, 65.86]	
Undergraduate or over	117 (14.6)	0.598	[0.559, 0.636]		63.80	[60.93, 66.67]	
Employment status				0.039			0.121
Unemployed	96 (12.0)	0.577	[0.535, 0.618]		62.86	[59.36, 66.37]	
Employed	200 (24.9)	0.590	[0.563, 0.618]		63.55	[61.21, 65.89]	
Retired	506 (63.1)	0.548	[0.530, 0.566]		60.78	[59.28, 62.28]	
Annual household income (¥)				0.269			0.292
< 20,000	152 (20.0)	0.545	[0.509, 0.581]		60.39	[57.11, 63.68]	
20,000 ~	160 (21.1)	0.568	[0.540, 0.595]		60.47	[57.87, 63.07]	
40,000 ~	155 (20.4)	0.550	[0.515, 0.584]		62.65	[60.25, 65.04]	
60,000 ~	112 (14.8)	0.577	[0.541, 0.613]		60.67	[57.41, 63.93]	
80,000 ~	132 (17.4)	0.595	[0.560, 0.631]		64.43	[61.84, 67.03]	
≥ 150,000	48 (6.3)	0.593	[0.533, 0.654]		62.92	[58.28, 67.55]	
Complication				< 0.001			< 0.001
Ischemic heart disease	175 (21.8)	0.620	[0.597, 0.642]		65.26	[63.06, 67.45]	
Acute myocardial infarction	112 (14.0)	0.434	[0.394, 0.473]		58.84	[55.46, 62.22]	
Congestive heart failure	88 (11.0)	0.471	[0.433, 0.510]		56.70	[53.17, 60.24]	
Stroke	153 (19.1)	0.472	[0.436, 0.508]		58.59	[55.52, 61.67]	
Impaired vision	114 (14.2)	0.714	[0.692, 0.737]		66.18	[63.40, 68.97]	
End-stage renal disease	115 (14.3)	0.693	[0.670, 0.717]		63.57	[60.49, 66.64]	
Ulcer	35 (4.4)	0.431	[0.375, 0.487]		60.86	[55.78, 65.94]	
Amputation	10 (1.2)	0.395	[0.341, 0.448]		55.00	[44.35, 65.65]	
BMI (kg/m^2)[b]				0.718			0.305
Underweight (BMI < 18.5)	28 (3.5)	0.519	[0.445, 0.594]		55.89	[48.84, 62.94]	
Normal (18.5 ≤ BMI < 24)	293 (36.5)	0.567	[0.543, 0.591]		61.52	[59.58, 63.46]	
Overweight (24 ≤ BMI < 28)	341 (42.5)	0.562	[0.540, 0.584]		62.18	[60.30, 64.07]	
Obese (BMI ≥ 28)	140 (17.5)	0.561	[0.526, 0.596]		62.18	[59.57, 64.79]	
Hypertension				0.334			0.032
No	265 (33.0)	0.572	[0.549, 0.596]		63.57	[61.57, 65.56]	
Yes	537 (67.0)	0.557	[0.539, 0.575]		60.81	[59.34, 62.28]	
Dyslipidemia				0.481			0.252
No	484 (60.3)	0.566	[0.548, 0.585]		62.28	[60.78, 63.79]	
Yes	318 (39.7)	0.556	[0.532, 0.579]		60.86	[58.94, 62.79]	
Current smoker				0.774			0.791
No	643 (80.2)	0.563	[0.547, 0.579]		61.64	[60.31, 62.97]	
Yes	159 (19.8)	0.558	[0.525, 0.591]		62.04	[59.40, 64.68]	

Table 1 (continued)

Variables	*N* (%)	EQ-5D utility score			EQ-VAS score		
		Mean	95% CI	*p*	Mean	95% CI	*p*
Current alcohol drinker				0.894			0.113
No	641 (79.9)	0.562	[0.546, 0.578]		61.24	[59.92, 62.56]	
Yes	161 (20.1)	0.564	[0.531, 0.597]		63.63	[60.89, 66.38]	
Exercise (h/day)				0.010			0.001
0	177 (22.1)	0.522	[0.489, 0.555]		57.88	[55.23, 60.54]	
< 2	511 (63.7)	0.571	[0.553, 0.588]		62.34	[60.88, 63.80]	
≥ 2	114 (14.2)	0.586	[0.550, 0.622]		64.91	[61.92, 67.90]	

One-way analysis of variance test was used

BMI body mass index, *SE* standard error, *CI* confidence interval

[a]Single refers to not married or not living in a partnership; not single refers to married or living in a partnership

[b]BMI category was defined based on 'criteria of weight for adults' by the National Health Commission of China [25]

Health-related quality of life

The most prevalent problem reported by T2DM inpatients hospitalized for a complication was impairment in usual activities (97%), followed by mobility (83.9%). A problem with self-care was the least reported (35.7%). When stratified by complication, the top two problems observed were still in usual activities and mobility in each subgroup. There were 94.3% of inpatients with IHD, 100% with AMI, 100% with CHF, 98% with stroke, 94.7% with impaired vision, 95.7% with ESRD, 100% with ulcer, and 100% with amputation reporting problems in usual activities. There were also 81.1% of inpatients with IHD, 95.5% with AMI, 95.5% with CHF, 93.5% with stroke, 63.2% with impaired vision, 70.4% with ESRD, 97.1% with ulcer, and 100% with amputation experiencing problems with mobility (Fig. 1; Table S2).

The mean EQ-5D utility of T2DM inpatients hospitalized for a complication was 0.562 (95% CI 0.548, 0.577). The utility varied significantly between the complications. The utility was 0.620 (95% CI 0.597, 0.642) for inpatients with IHD, 0.434 (95% CI 0.394, 0.473) for AMI, 0.471 (95% CI 0.433, 0.510) for CHF, 0.472 (95% CI 0.436, 0.508) for stroke, 0.714 (95% CI 0.692, 0.737) for impaired vision, 0.693 (95% CI 0.670, 0.717) for ESRD, 0.431 (95% CI

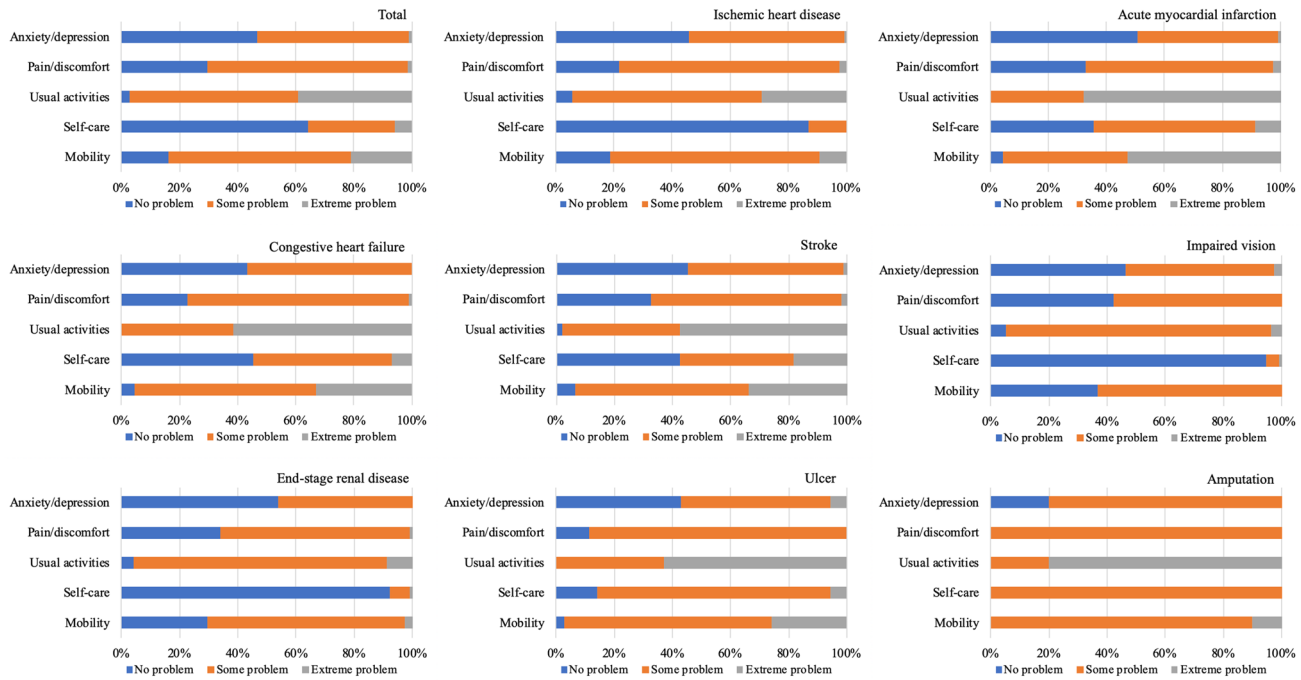

Fig. 1 Distribution of the EQ-5D problems reporting among type 2 diabetes inpatients

0.375, 0.487) for ulcer, and 0.395 (95% CI 0.341, 0.448) for amputation (Fig. 2; Table 1).

The mean EQ-VAS score of T2DM inpatients hospitalized for a complication was 61.72 (95% CI 60.53, 62.91). The EQ-VAS scores also differed significantly between the complications. The score was 65.26 (95% CI 63.06, 67.45) for inpatients with IHD, 58.84 (95% CI 55.46, 62.22) for AMI, 56.70 (95% CI 53.17, 60.24) for CHF, 58.59 (95% CI 55.52, 61.67) for stroke, 66.18 (95% CI 63.40, 68.97) for impaired vision, 63.57 (95% CI 60.49, 66.64) for ESRD, 60.86 (95% CI 55.78, 65.94) for ulcer, and 55.00 (95% CI 44.35, 65.65) for amputation (Table 1).

A significant positive correlation was found between the EQ-5D utility and EQ-VAS score for the total sample with a coefficient of 0.508. When stratified by complication, except for inpatients with amputation, the EQ-5D utility and EQ-VAS score still showed a significant positive correlation (Table S3).

Factors associated with health-related quality of life

A univariate analysis found associations between HRQoL and age, education level, complication, and exercise. Inpatients who were older, with a lower education level, with a complication, or who had no daily exercise reported a significantly lower EQ-5D utility and EQ-VAS score (Table 1).

In the multivariate regression, however, age and education level were no longer significantly associated with the EQ-5D utility and EQ-VAS score after adjusting for other variables. The strongest determinant of reduced EQ-5D utility in T2DM inpatients was the existence of a complication. When compared with inpatients with IHD, those with amputation, AMI, ulcer, stroke, or CHF had significantly lower EQ-5D utility, while those with ESRD or impaired vision had higher EQ-5D utility. In terms of the EQ-VAS score, when compared with inpatients with IHD, those with AMI, stroke and CHF were still associated with a significantly lower EQ-VAS score, while those with impaired vision, ESRD, ulcer and amputation were not. Additionally, female inpatients had lower EQ-5D utility than males. Inpatients who had daily exercise reported a higher EQ-5D utility and EQ-VAS score than those who had no daily exercise (Table 2).

Discussion

HRQoL is one of the important outcomes used to estimate the effect of T2DM and its complications on health. The utility as measured by the EQ-5D is endorsed as a suitable input parameter in cost-effectiveness analyses [34]. This is the first study focused on investigating the utility-based HRQoL of

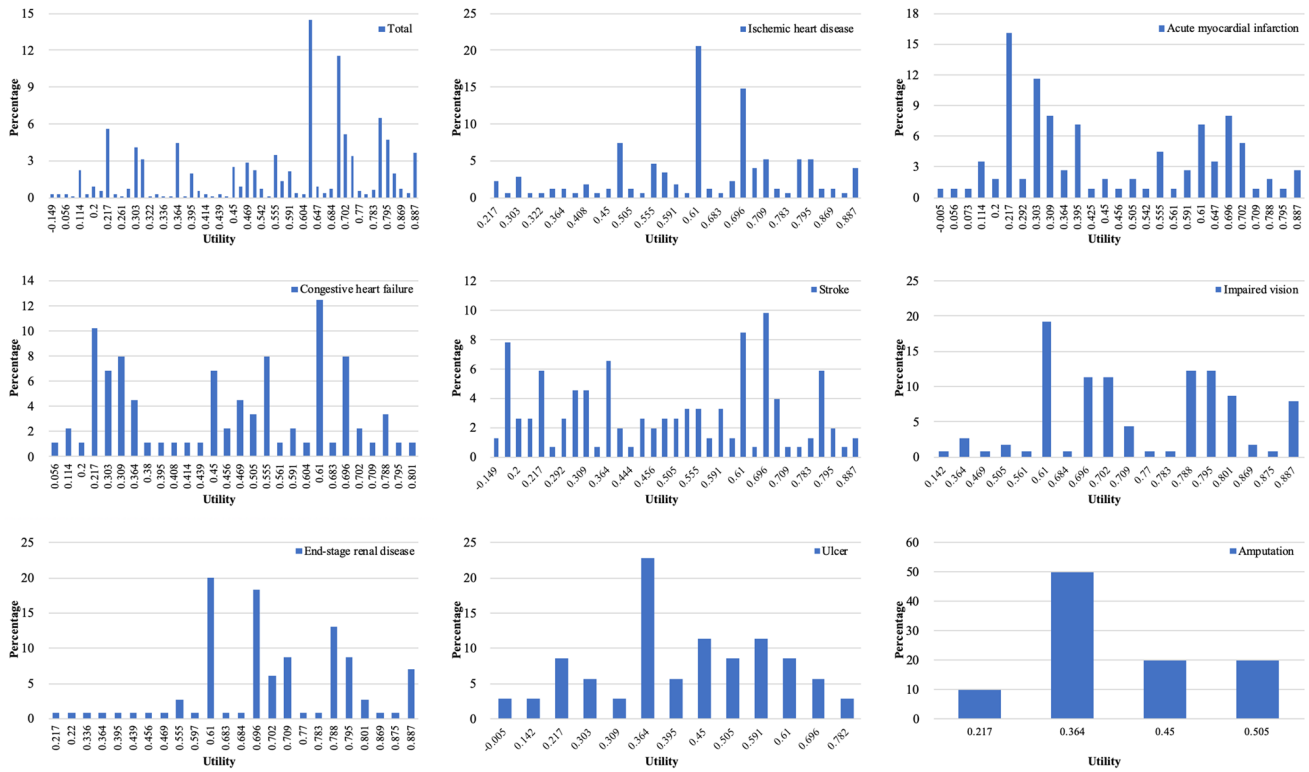

Fig. 2 Distribution of the EQ-5D utility scores of type 2 diabetes inpatients

Table 2 Association between type 2 diabetes inpatients' characteristics and EQ-5D utility, EQ-VAS score using a Tobit regression model

Variables	EQ-5D utility score			EQ-VAS score		
	Coef	95% CI	*p*	Coef	95% CI	*p*
Gender (ref = male)						
Female	−0.045	[−0.074, −0.017]	0.002	−1.663	[−4.421, 1.096]	0.237
Age, years (ref = < 45)						
45–64	0.003	[−0.049, 0.056]	0.904	−3.450	[−8.537, 1.637]	0.183
≥ 65	−0.021	[−0.080, 0.038]	0.483	−2.324	[−8.054, 3.406]	0.426
Marital status (ref = single)[a]						
Not single	0.000	[−0.037, 0.038]	0.993	−1.210	[−4.843, 2.422]	0.513
Education level (ref = junior high school or below)						
Senior high school	0.027	[−0.002, 0.055]	0.071	3.260	[0.468, 6.053]	0.022
Undergraduate or over	0.019	[−0.018, 0.055]	0.316	2.331	[−1.193, 5.854]	0.194
Employment status (ref = unemployed)						
Employed	−0.008	[−0.053, 0.037]	0.725	−1.974	[−6.320, 2.373]	0.373
Retired	−0.015	[−0.056, 0.026]	0.464	−2.795	[−6.740, 1.149]	0.165
Complication (ref = ischemic heart disease)						
Acute myocardial infarction	−0.190	[−0.231, −0.149]	< 0.001	−6.796	[−10.763, −2.830]	0.001
Congestive heart failure	−0.129	[−0.174, −0.084]	< 0.001	−7.758	[−12.111, −3.406]	< 0.001
Stroke	−0.145	[−0.182, −0.107]	< 0.001	−6.469	[−10.080, −2.857]	< 0.001
Impaired vision	0.099	[0.058, 0.141]	< 0.001	0.603	[−3.412, 4.618]	0.768
End-stage renal disease	0.085	[0.041, 0.128]	< 0.001	−0.606	[−4.813, 3.600]	0.777
Ulcer	−0.173	[−0.236, −0.109]	< 0.001	−3.034	[−9.164, 3.095]	0.331
Amputation	−0.223	[−0.334, −0.112]	< 0.001	−8.202	[−18.958, 2.555]	0.135
BMI, kg/m^2 (ref = underweight < 18.5)[b]						
Normal (18.5 ≤ BMI < 24)	0.067	[−0.001, 0.134]	0.052	6.343	[−0.183, 12.87]	0.057
Overweight (24 ≤ BMI < 28)	0.062	[−0.006, 0.130]	0.074	6.388	[−0.207, 12.983]	0.058
Obese (BMI ≥ 28)	0.076	[0.005, 0.148]	0.036	7.669	[0.736, 14.602]	0.030
Hypertension (ref = no)	−0.016	[−0.043, 0.011]	0.248	−2.603	[−5.197, −0.01]	0.049
Dyslipidemia (ref = no)	0.012	[−0.014, 0.037]	0.364	−0.076	[−2.53, 2.377]	0.951
Current smoker (ref = no)	−0.015	[−0.049, 0.020]	0.404	−0.668	[−4.008, 2.673]	0.695
Current alcohol drinker (ref = no)	0.003	[−0.032, 0.038]	0.873	1.233	[−2.132, 4.598]	0.472
Exercise, h/day (ref = 0)						
< 2	0.037	[0.007, 0.068]	0.016	3.753	[0.824, 6.683]	0.012
≥ 2	0.054	[0.011, 0.097]	0.013	6.181	[2.046, 10.317]	0.003

Ref reference group, *BMI* body mass index, *SE* standard error, *CI* confidence interval, *Coef.* coefficient

[a]Single refers to not married or not living in a partnership; not single refers to married or living in a partnership

[b]BMI category was defined based on 'criteria of weight for adults' by the National Health Commission of China [25]

T2DM inpatients in China who were hospitalized for a major chronic complication using the EQ-5D. This study reported an average EQ-5D utility of 0.562 for T2DM inpatients hospitalized for a complication. Inpatients with amputation reported the lowest utility, followed by those with ulcer, AMI, CHF, stroke, IHD, ESRD, and impaired vision. A positive correlation was found between EQ-5D utility and EQ-VAS score. The mean EQ-VAS score was 61.72. Those with an amputation reported the lowest score, while those having impaired vision reported the highest score.

Our findings demonstrated that T2DM inpatients with a complication suffered from considerable impairment in HRQoL. Therefore, it is crucial to the improvement of T2DM management to prevent complications. However, the treatment rate of Chinese T2DM patients is low, often leading to poor glycemic control [26]. Moreover, T2DM is often undiagnosed at the early stage, which delays treatment [1, 26]. Therefore, the efforts of our government and medical institutions are important to increase patients' treatment awareness and to achieve early diagnosis and treatment. For inpatients with a complication, in addition to effective medical treatment, hospital staff should provide health promotion-related courses, psychosocial interventions, and other support services to promote the recognition and skills

concerning self-care behavior and health improvement. Additionally, T2DM management should be coordinated between hospitals and community medical institutions to achieve effective tracking and treatment.

The estimates from our study were lower than the reports of previous studies [8, 14, 20–22]. The main reason for this difference was that our target participants were T2DM inpatients hospitalized for a complication rather than T2DM outpatients with preexisting complications, as in previous studies [8, 14, 20–22]. An impairment in HRQoL is linked to the severity of the complications [19]. T2DM inpatients hospitalized for a complication have more severe symptoms than outpatients with a complication. Therefore, at the stage of hospitalization for a complication, the HRQoL of a patient is the lowest. However, the HRQoL will improve to some extent with the progression of treatment, the improvement of the complication, and the patient gradually adapting to having the complication over time, especially after discharge. Additionally, the differences in the estimates may be somewhat related to multiple other factors such as the differences in the study populations, the quality of T2DM care and the availability of access to support services [35]. Our estimates quantified the utility-based HRQoL of T2DM inpatients hospitalized for a complication, which complements previous studies conducted in outpatients. Our estimates combined with the estimates of previous studies can provide more comprehensive utility data for public health and cost-effectiveness modeling and increase the breadth of knowledge of HRQoL in T2DM.

The results from the UKPDS series studies, a meta-analysis and other studies published in China and other Asian countries showed that utility-based HRQoL of T2DM outpatients was significantly affected by major complications such as IHD, CHF, stroke, myocardial infarction, ESRD, amputation, blindness, and ulcer [8, 14, 19, 21, 22, 24, 32]. Our study further detected a strong association between these complications and an impaired HRQoL of T2DM inpatients, which supplemented existing information. Additionally, we also observed a significant difference in the HRQoL between different genders and exercise groups. Female inpatients had a lower HRQoL than males, while inpatients who had daily exercise reported a better HRQoL than those without exercise. Both observations were consistent with the findings of previous studies on outpatients [14, 31–33, 36]. Some evidence identified that age and education level were negatively associated with HRQoL [31–33], while other studies found the associations were not significant [5, 8]. Our study also did not observe significant associations between age, education level and HRQoL among inpatients. The inconsistency between the different studies may be attributed to the differences in the study populations, disease severity, study design, instrument and tariff used. Our observations, along with the findings of previous studies, could help clinicians identify patients at risk of HRQoL deterioration and help hospital staff provide personalized medical and psychosocial interventions.

There were several limitations that should be noted. First, this study was conducted in one tertiary hospital, which may not be truly representative of all T2DM inpatients in China, thus limiting the generalization of the results to the whole country. Second, bias might arise because sicker inpatients (e.g., those who were unconscious) did not respond to the survey, which might increase the mean utility associated with inpatients hospitalized for a complication. Third, we only identified the main complication for inpatients but did not handle the potential history of other complications that were not the main diagnosis leading to hospital admission. Fourth, this study used EQ-5D-3L to estimate the HRQoL rather than EQ-5D-5L, which is a new version of EQ-5D that has better measurement properties and precision. This study was designed in 2016 and conducted in early 2017, and at that time, the EQ-5D-3L was widely used and well recognized in China with a validated country-specific 3L social value set, while EQ-5D-5L was not commonly used, and there was no validated country-specific 5L social value set. Fifth, because this study aimed to estimate the HRQoL of inpatients hospitalized for a complication in general, we did not specifically study the relationship between the length of the hospital stays (or the duration of the complication) and HRQoL. Sixth, this study did not differentiate between first and second events of a complication. However, the utility decrement may differ between secondary and primary events, which should be noted when our estimates are used in economic evaluations. Last, this was a cross-sectional study that was only able to detect associations but not causation. Therefore, in future studies, a longitudinal study that includes the whole hospital care system across the country is needed to draw a solid conclusion on the causal pathway of the associations and to enhance the generalization of the results. In addition, it is also important to identify and address all potential complications of the patients and to study the relationship between the duration of complications and HRQoL, as the impact can vary with the number and duration of complications.

Conclusion

The HRQoL of Chinese T2DM inpatients hospitalized for a complication was considerably impaired, which implied that improved management is crucial to prevent complications. For inpatients with a complication, in addition to effective medical treatment, social support services are important. Our estimates quantified the impact of eight major chronic complications on utility-based HRQoL in the stage of hospitalization, which could be used to complement previous

studies for public health and cost-effectiveness modeling, and increased the breadth of knowledge of HRQoL in T2DM. The detected association between poor HRQoL and clinical conditions may guide efforts to improve the HRQoL of T2DM patients.

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Author contributions The authors all made substantial contributions to the analysis. SG designed the study, researched and analyzed the data, and wrote, reviewed and edited the manuscript. HD designed the study, and reviewed and edited the manuscript. XW and XH researched and analyzed the data. LS reviewed and edited the manuscript. QS, YG, and XS researched the data.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the Ethical Standards of the Institutional and/or National Research Committee (Medical Faculty Ethics Committee of Zhejiang University + ZGL201606-2) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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