VIA MEDICA
RESEARCH PAPER
ISSN 2450–7458
e-ISSN 2450–8187

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Predictors of quality of life in people living with type-1 and type-2 diabetes: an Indian perspective study and systematic review

ABSTRACT

Background: This study evaluated predictors of good quality of life (QOL), in people with type-1 diabetes (T1DM) and type 2 diabetes (T2DM) using validated general health questionnaire [World Health Organization's (WHO)-QOL-Brief (BREF) questionnaire] and diabetes-specific questionnaire [Multidimensional Diabetes Questionnaire (MDQ)].

Methods: Consecutive people > 18 years age, having T1DM or T2DM of > 6 months duration, without any severe co-morbid states or hospital admission in last 3 months, attending endocrinology-clinics of 3 different centers in Delhi, between August 2014 to September 2019, underwent QOL assessment. PubMed and Medline search for articles published to till November 2019 on QOL in diabetes was done for systematic review.

Results: Data from 2067 patients was analyzed. WHO-QOL-BREF aggregate score was significantly better in T2DM compared to T1DM (3.39 ± 0.46 vs. 3.11 ± 0.63; p < 0.001). T1DM did significantly better than T2DM patients only with regards to physical health. T1DM patients' QOL scores were worse for psychological, social relationship, and environmental domains. Analysis based on quartiles of WHO-QOL-BREF aggregate score revealed people in Quartile-4 were significantly older, had the lowest hypoglycemia, nephropathy, retinopathy, neuropathy, CAD, and peripheral artery disease. Patients with the lowest QOL (Quartile-1) had the highest blood glucose and HbA1c. Step-wise linear regression revealed age, sex, diabetes type, duration, HbA1c, hypoglycemia, nephropathy, neuropathy, and coronary artery disease to be independent predictors of QOL. Every percent increase in HbA1c was associated with a 2.1% reduction in aggregate QOL score. Hypoglycemia, the presence of nephropathy, and neuropathy were associated with a 9.1%, 11.4%, and 7.8% reduction in QOL aggregate score.

Conclusions: Younger age, female sex, T1DM, disease duration, glycaemic control, hypoglycemia end-organ damage are important predictors of poor QOL in Indians. Insulin use and a number of medications have no impact on QOL. (Clin Diabetol 2022, 11; 1: 33–44)

Keywords: diabetes, quality of life, India, morbidity

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Clinical Diabetology 2022, 11; 1: 33–44
DOI: 10.5603/DK.a2021.0057
Received: 5.07.2021 Accepted: 24.10.2021

Introduction

Quality of life (QOL) is perhaps one of the most important, but oft-neglected aspects of assessing treatment response in people living with chronic diseases like diabetes. QOL can be assessed by validated standardized general/generic health questionnaires (GHQ) as

well as disease-specific questionnaires (DSQ) [1, 2]. Assessing QOL using GHQ helps in comparing QOL among people living with different disorders across specialties. However being general in nature, GHQ may at times fail to assess the finer aspects of QOL in patients living with a particular disease. This necessitates the use of DSQ which is tailor-made for a particular disease state and helps in comparing the finer details of QOL among people living with the same condition.

In diabetes it is not only important that the patients have good glycaemic control to prevent microvascular and macrovascular complications of diabetes, ensuring a good QOL will result in better patient satisfaction and compliance, all of which shall contribute to a decrease in patient morbidity and mortality. There is scant data on QOL assessment among people living with diabetes in India. Hence the aim of this study was to compare the different aspects of QOL and determine the predictors of good QOL in people living with type-1 diabetes (T1DM) and type-2 diabetes (T2DM) using a validated GHQ [World Health Organization's (WHO)-QOL-Brief (BREF) questionnaire] and a diabetes-specific DSQ [Multidimensional Diabetes Questionnaire (MDQ)].

Methods

Questionnaires are self-administered tools for the assessment of QOL. The advantage of a questionnaire over an interview sheet, which is administered to a patient by an interviewer, is that it is free from several biases associated with the interview sheet. Since a patient self-fills a questionnaire in privacy, it's more likely that the responses would be a better representation of the state of the mind of the individual.

The WHOQOL questionnaire is a generic QOL assessment tool in English, developed simultaneously in 15 centers across the globe by the WHOQOL Group, division of mental health and prevention of substance abuse, WHO Geneva [1, 2]. It is one of the most common generic QOL tools used across the globe [2]. A validated Hindi translation of the WHOQOL questionnaire was developed by Saxena S et. al. from the All India Institute of Medical Sciences (AIIMS) New Delhi [1]. WHO-QOL Hindi questionnaire is available in 2 versions, a long 100-item version, WHOQOL-Hindi-100, and a brief 26-item version (The WHO-BREF-QOL-Hindi Questionnaire). The WHO-BREF-QOL-Hindi Questionnaire is easier to administer and is more useful for repeated assessment of QOL over a period of time [1]. Hence WHO-BREF-QOL-Hindi Questionnaire was used as a generic tool for the assessment of QOL among patients with DM in our study.

The four domains of the WHO-BREF-QOL Hindi questionnaire are: domain 1, which involves assessment of physical health, domain 2 includes assessment of psychological well-being, domain 3 pertains to social relationships and domain 4 pertains to the environment. Subjects had to rate all items on a 5-point Likert-type scale. An average was obtained from the scores of each of the 4 individual domains to get the WHO-BREF-QOL Hindi score. A lower score (individual domain as well as total) implies a lower QOL whereas a higher score implies a better/higher QOL.

The validated Hindi translation of the Multi-dimensional Diabetes Questionnaire (MDQ) is a diabetes-specific tool for QOL assessment among patients with diabetes was used in our study [3]. The original MDQ questionnaire was developed in English by Dr. Arie Nouwen University of Birmingham, Edgbaston, UK, which comprises three sections focusing on general perceptions of diabetes and related social support, social incentives, self-efficacy, and outcome expectancies in relation to self-care activities [3] A validated Hindi translation of MDQ used in this study was developed by Pawar et al. [3]. The validation process consisted of 4 steps which included translation of the English questionnaire to Hindi, assessment of reliability and validity in a pilot cohort of patients, followed by forward and backward translation [3]. Consent was obtained from Saxena S et. al. and Pawar et. al. [3] for clinical use of their Hindi QOL tool for research purposes in our study.

Consecutive people living with diabetes more than 18 years of age attending the endocrinology clinics of 3 different centers in New Delhi were considered for the study. The study duration was from August 2014 to September 2019. People with diabetes diagnosed for at least 6 months duration were considered for the study. For people on insulin therapy, those on some form of insulin therapy for atleast 6 months were considered for this study. Severely ill patients with multiple co-morbid states, which would warrant hospital admission, were excluded. People with a history of hospital admission in the last 3 months were also excluded. The study was approved by the Institute's ethics committee of PGIMER and Dr RML Hospital New Delhi (No.95(19/2014)/IEC/PGIMER/RML)/1647 dated 18th Nov 2014). The study protocol was explained to the participants, and only those who gave informed written consent were included in the study.

An expert, who is proficient in both English and Hindi counseled and administered the WHO-BREF--Hindi questionnaire and the MDQ-Hindi questionnaire to the participants. The participants self-filled the questionnaires in a cool, well-lit, quiet, peaceful, and secluded room. They had the option of clarifying any doubts from the expert during filling of the questionnaires, who was sitting outside the room. Thereafter

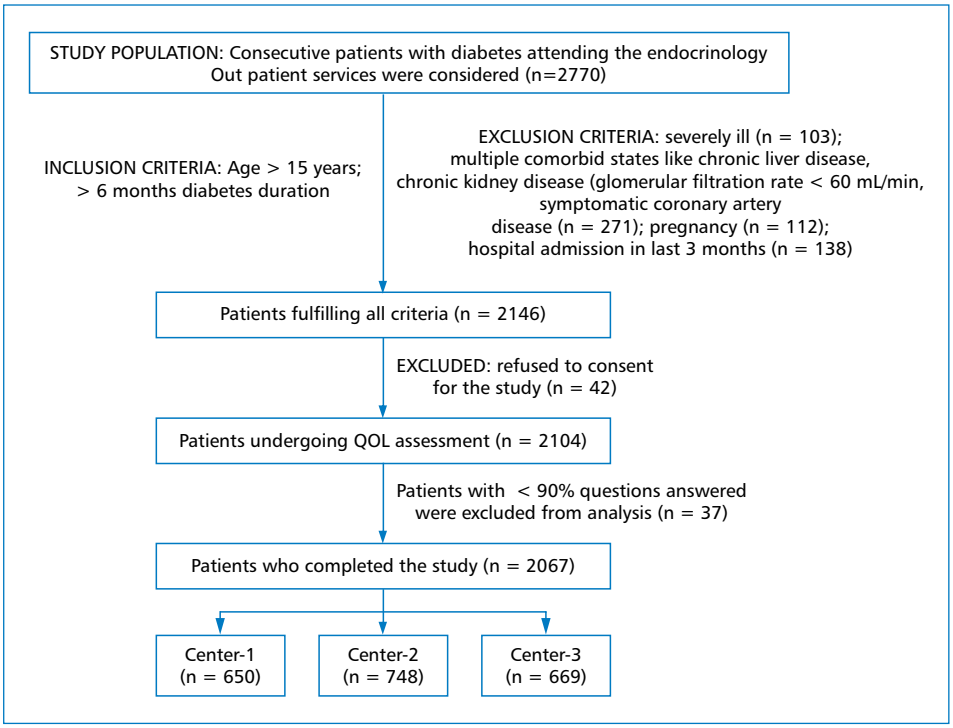

Figure 1. Flowchart elaborating the study protocol and flow of patients
QOL — quality of life

a physician interacted with and evaluate the patients. Information regarding demographics and biodata was collected. Data were collected regarding the duration of diagnosis, duration of pharmacotherapy for diabetes, and types of medications used. Socio-demographic data were also collected. All participants underwent detailed clinical assessment, anthropometry assessment, blood pressure, screening for foot complication of diabetes, 10 gram Semmes Weinstein monofilament test, and pinprick assessment to rule out neuropathy. Biochemical data were noted from the patient's records would include recent (within the previous 1 month), fasting blood glucose (FBG), post-prandial blood glucose (PPBG), HbA1c, lipid profile, and creatinine.

PubMed and Medline, search for articles published to July 2020, using the terms "quality of life" [MeSH] AND "diabetes" [All Fields] was done for the systematic review. The reference lists of the articles thus identified were also searched. The search was not restricted to English-language literature. Articles whose primary outcome was QOL assessment in people living with diabetes were considered for the literature review. Drug trials, where QOL assessment was a secondary outcome were not considered for the review.

Statistical analysis

The normality of the distribution of variables was checked using the Kolmogorov-Smirnov test. Independent t-test and Wilcoxon rank-sum test were done for normally distributed and skewed variables, respectively. Chi-square tests were used for categorical variables. A p-value < 0.05 was considered statistically significant. Statistical Package for the Social Sciences (SPSS) version 20 (Chicago, IL, USA) was used for data analysis.

Results

A total of 2770 patients living with diabetes were considered for this study, from which data from 2067 patients who fulfilled all inclusion and exclusion criteria, gave informed written consent, and completed the study were analyzed. The entire flow of patients in the study has been elaborated in Figure 1. The clinical, anthropometric, biochemical, and QOL outcomes of people living with T1DM and T2DM have been elaborated in Table 1. Patients with T1DM were significantly younger, had a greater percentage of males, had lower BMI, disease duration, and lower occurrence of end-organ damage (retinopathy, neuropathy, coronary artery disease) (Tab. 1). Glycaemic control was significantly worse in people living with T1DM as compared to T2DM (Tab. 1). HDL-C was significantly higher and triglycerides significantly lower in people living with T1DM (Tab. 1).

Overall general QOL score (WHO-QOL-BREF aggregate score) was significantly better in people living with T2DM as compared to T1DM (3.39 ± 0.46 vs.

Table 1. Comparison of clinical and quality of life profile of people living with type 1 diabetes vs. type 2 diabetes (n = 2067)

Parameter	Type 1 diabetes (n = 185)	Type 2 diabetes (n = 1882)	P
Age [years]	23.18 ± 6.86	55.55 ± 11.32	< 0.001
Sex (male: female)	122: 63	886: 996	< 0.001
Duration of diabetes [months]*	36 [24–120]	96 [45–180]	< 0.001
Duration of pharmacotherapy [months]*	36 [18–120]	96 [36–180]	< 0.001
BMI [kg/m^2]	20.83 ± 3.71	25.01 ± 4.16	< 0.001
Waist circumference [cm]	86.22 ± 14.17	94.35 ± 18.6	< 0.001
Hypertension	34 (18.37%)	685 (36.39%)	< 0.001
Nephropathy	62 (33.51%)	485 (25.77%)	0.962
Retinopathy	5 (0.03%)	315 (16.73%)	< 0.001
Neuropathy	68 (36.75%)	759 (40.3%)	0.001
CAD	0	186 (9.88%)	< 0.001
CVA	0	14 (0.01%)	0.238
PAD	0	16 (0.01%)	0.208
Diabetic Foot	6	60 (3.18%)	0.440
Hypoglycemia	162 (87.56%)	983 (52.23%)	< 0.001
Fasting glucose [mg/dL]*	147 [108–197]	147 [119–193]	0.187
2h post prandial Glucose [mg/dL]*	265 [143–313]	225 [177–287]	0.127
HbA1c [%]	9.5 ± 1.83	8.36 ± 1.9	< 0.001
Total cholesterol*	145 [134–167]	158 [129–185]	0.158
LDL-C*	90 [75.75–103]	89 [68–110]	0.633
HDL-C*	48.5 [40–58]	41 [35–49]	< 0.001
Triglycerides*	68.7 [58–120]	137.5 [103–179]	< 0.001
Creatinine*	0.60 [0.50–0.74]	0.8 [0.7–1.05]	< 0.001
WHO-QOL-BREF aggregate score	3.11 ± 0.63	3.39 ± 0.46	< 0.001
WHO-QOL-BREF score adjusted for who-100	12.47 ± 2.5	13.58 ± 1.87	< 0.001
WHO-QOL-BREF domain score			
Physical health	3.07 ± 0.65	2.95 ± 0.64	0.015
Psychological	3.12 ± 0.75	3.43 ± 0.57	< 0.001
Social relationship	3.31 ± 1.02	3.75 ± 0.68	< 0.001
Environmental	3.28 ± 0.74	3.51 ± 0.59	< 0.001
MDQ score			
Interference	3.45 ± 1.33	3.81 ± 1.17	0.005
Social support	4.75 ± 1.56	5.10 ± 1.33	0.020
Severity	4.02 ± 1.42	4.01 ± 1.52	0.934
Positive reinforcement behaviour	4.14 ± 1.44	4.77 ± 1.16	< 0.001
Negative reinforcement behaviour	3.84 ± 1.83	4.63 ± 1.38	< 0.001
Self efficacy	77.56 ± 14.17	83.23 ± 21.11	0.027
Outcome expectancies	87.87 ± 12.94	88.67 ± 10.52	0.332

*non-normally distributed, expressed as median [25th–75th percentile]
BMI — body mass index; BREF — brief; CAD — coronary artery disease; CVA — cerebrovascular accident; HbA1c: glycated hemoglobin; HDL — high-density lipoprotein; LDL —low-density lipoprotein; MDQ — Multi-dimensional Diabetes Questionnaire; PAD — peripheral artery disease; QOL: quality of life; WHO: World Health Organization

3.11 ± 0.63 respectively; p < 0.001). When the specific domains of WHO-QOL = BREF were analyzed, T1DM patients did significantly better than T2DM patients only with regards to physical health (Tab. 1). The QOL scores were significantly worse (lower) in T1DM patients for psychological, social relationship, and environmental domains in people living with T1DM as compared to T2DM (Tab. 1).

When the different domains were analyzed in the diabetes-specific questionnaire (MDQ questionnaire),

people living with T2DM were doing significantly better than T1DM with regards to interference in day to day life cause of diabetes, social support in terms of diabetes care, performed better with regards to both positive and negative reinforcement behavior related to diabetes care (Tab. 1). Self-efficacy and independence with regards to diabetes care and day-to-day life were better in people living with T2DM as compared to T1DM (Tab. 1). Both people with T1DM and T2DM had a similar perception of their disease severity and their expectancies with regards to long-term disease outcomes (Tab. 1).

Analysis based on quartiles of WHO-QOL-BREF aggregate score with the highest quartile (Quartile-4) representing the best QOL and the lowest quartile (Quartile-1) representing the worst QOL, revealed that people in Quartile-4 were significantly older, had the lowest occurrence of hypoglycemia, nephropathy, retinopathy, neuropathy, CAD and peripheral artery disease, which was statistically significant (Tab. 2). Patients with the lowest QOL scores (Quartile-1) had the highest fasting blood glucose, postprandial blood glucose, and HbA1c among all 4 groups, which was statistically significant (Tab. 2). People with diabetes in Quartile-4 uniformly had the best physical health, psychological, social relationship, and environmental domain score (Tab. 2). People with diabetes in quartile-4 of WHO-QOL-BREF aggregate score perceived that they have the best social support in terms of diabetes care, self-efficacy, and outcome expectancies with regards to diabetes (different domains of MDQ questionnaire) (Tab. 2).

WHO-QOL-BREF aggregate score had a strong positive and statistically significant correlation with all the 4 different sub-domains of the score (physical health, psychological, social relationship, and environmental) (Tab. 3). WHO-QOL-BREF aggregate score had a statistically significant negative correlation with interference and severity domains of MDQ questionnaire and positive correlation with social support, positive reinforcement behavior, negative reinforcement behavior, self-efficacy, and outcome expectancies domains of MDQ questionnaire (Tab. 3).

Step-wise linear regression was initially performed with all parameters, which are likely to influence the WHO-QOL-BREF QOL score [age, sex, body mass index (BMI), type of diabetes, duration of diabetes, number of medications, insulin use, number of insulin pricks per day, HbA1c, lipid parameters, presence of neuropathy, nephropathy, retinopathy, coronary artery disease (CAD), peripheral artery disease (PAD), history of cerebrovascular accident (CVA), hypoglycemia]. Parameters with $p < 0.2$ were included in the final model as elaborated in the table 4. Age, sex, type of diabetes, duration of diabetes, HbA1c, the occurrence of hypoglycemia, nephropathy, neuropathy, and CAD were found to be independent predictors. Type 1 diabetes was per se an independent predictor of poor QOL. Increased HbA1c was an independent predictor of QOL. Every percent unit increase in HbA1c was associated with a 2.1% reduction in aggregate QOL score. Increased occurrence of hypoglycemia, nephropathy, neuropathy, and CAD were all independent predictors of worse QOL. Occurrence of hypoglycemia, presence of nephropathy, and neuropathy were associated with 9.1%, 11.4%, and 7.8% reduction in QOL aggregate score.

An initial PubMed and Medline search revealed 16,937 articles. After screening the title of the articles, the number of articles at focus came down to 1327. After a review of the abstracts of these articles, the number of articles in interest came down to 141. After a detailed review of these manuscripts, a total of 46 articles have been included and discussed in Table 5 and the discussion section.

Discussion

Diabetes has been demonstrated to have a significant impact on the physical as well as psychological well-being of an individual [4]. Hence psychological well-being assessment should be an important goal of any standard diabetes management program. QOL assessment is an important tool for the assessment of psychological well-being and patient satisfaction and hence is more compatible with the WHO definition of health [4]. QOL assessment can guide the development/modulation of treatment strategies, and act as one of the measures for assessing treatment outcomes [5]. We have previously reported worse QOL scores and increased occurrence of depression in people living with T2DM as compared to healthy controls [6].

The very high HbA1c both in people living with T1DM and T2DM in this study is suggestive that a lot more needs to be done to improve the glycaemic control in these individuals, which is likely to have a beneficial impact on long term clinical, end-organ damage, and QOL outcomes. The BMI was significantly higher in T2DM with regards to T1DM (25.01 ± 4.16 vs. 20.83 ± 3.71 kg/m^2 respectively). This is in accordance with previous reports showing that T2DM in urban India is predominantly diabesity. From a cohort of 5336 individuals with or without diabetes from New Delhi, the prevalence of obesity was 69.29% [7]. The mean waist circumference was significantly higher in T2DM as compared to T1DM. Further, the mean waist circumference in people with T2DM was 94.35 ± 18.6 cm which is more than the 80 cm and 90 cm cut-off for

Table 2. Clinical and biochemical profile of people living with diabetes based on quartiles of WHO-QOL-BREF aggregate Score (n = 2067)

Parameter	WHO QOL BREF QUARTILES				P
	QUARTILE-1 [1.65–3.15] n = 529	QUARTILE-2 [3.15–3.38] n = 551	QUARTILE-3 [3.38–3.65] n = 528	QUARTILE-4 [3.65–6.35] n = 459	
Age [years]	49.66 ± 14.36	54.88 ± 12.17	52.5 ± 12.02	55.5 ± 11.34	< 0.001
Sex (male: female)	252: 277	238: 313	260: 268	258: 201	< 0.001
T1DM: T2DM	96	33	28	24	
Duration of diabetes [months]*	72 [30–144]	96 [48–180]	108 [48–168]	84 [24–180]	< 0.001
Duration of pharmacotherapy [months]*	72 [24–144]	96 [48–180]	96 [36–144]	84 [24–180]	< 0.001
BMI [kg/cm^2]	25.15 ± 5.1	24.2 ± 3.32	24.46 ± 3.64	25.17 ± 4.47	0.001
Waist circumference [cm]	96.16 ± 20.74	90.56 ± 15.79	92.82 ± 14.71	98.24 ± 18.54	< 0.001
Hypertension	191 (36.1%)	212 (38.47%)	162 (30.68%)	154 (33.55%)	0.043
Nephropathy	146 (27.59%)	222 (40.29%)	110 (20.83%)	69 (15.03%)	< 0.001
Retinopathy	56 (10.58%)	126 (22.86%)	80 (15.15%)	58 (12.63%)	< 0.001
Neuropathy	222 (41.96%)	276 (50.09%)	208 (39.39%)	121 (26.36%)	< 0.001
CAD	48 (9.07%)	66 (11.98%)	44 (8.33%)	28 (6.1%)	0.016
CVA	0	2 (0.003%)	8 (0.02%)	4 (0.01%)	0.015
PAD	6 (0.01%)	6 (0.01%)	4 (0.01%)	0	0.170
Hypoglycemia	335 (63.32%)	358 (64.92%)	250 (47.34%)	202 (44.0%)	< 0.001
Insulin	308 (58.22%)	280 (50.81%)	232 (43.93%)	220 (47.93%)	0.003
Number of medications for diabetes management (n)					
One	178 (33.64%)	105 (19.05%)	127 (24.05%)	100 (21.78%)	< 0.001
Two	185 (34.97%)	202 (36.67%)	181 (34.28%)	169 (36.81%)	0.787
Three	95 (17.95%)	143 (25.95%)	106 (20.07%)	105 (22.87%)	0.010
Four	61 (11.53%)	89 (16.15%)	94 (17.80%)	77 (16.77%)	0.002
Five	10 (1.89%)	12 (2.18%)	20 (3.78%)	8 (1.74%)	0.119
Fasting glucose [mg/dL]*	157.5 [120–210]	145 [115–180]	144 [116–191]	146 [122–189]	0.009
2h post prandial glucose [mg/dL]*	250 [186–303]	219 [173–272]	206 [159–282]	237 [180–284]	< 0.001
HbA1c (%)*	8.2 [6.99–10.17]	8.2 [6.97–9.5]	7.8 [6.8–9.3]	8.0 [7.0–9.6]	0.003
Total cholesterol*	152 [129–181]	156 [124–187]	157 [132–178]	158 [127–182]	0.845
LDL-C*	87 [65–107.25]	90.5 [65–119]		89 [68–102]	0.831
HDL-C*	42 [35–50]	40 [35–47.75]	40.5 [30–48.5]	41.6 [35–50]	0.015
Triglycerides*	130 [94.25–159]	127 [103–174]	142 [91–187.7]	143 [105–184]	0.026
Creatinine*	[]	0.80 [0.7–1.1]	0.82 [0.67–1.0]	0.80 [0.72–1.0]	0.410
WHO-QOL-BREF domain score					
Physical health	2.54 ± 0.48	2.88 ± 0.34	3.07 ± 0.35	3.60 ± 0.80	< 0.001
Psychological	2.78 ± 0.46	3.34 ± 0.29	3.63 ± 0.26	4.05 ± 0.39	< 0.001
Social relationship	3.11 ± 0.8	3.78 ± 0.46	3.90 ± 0.46	4.21 ± 0.53	< 0.001
Environmental	2.91 ± 0.49	3.37 ± 0.22	3.65 ± 0.26	4.17 ± 0.64	< 0.001
MDQ score					
Interference	3.7 ± 1.09	4.13 ± 0.87	4.08 ± 1.04	3.19 ± 1.48	< 0.001
Social support	4.68 ± 1.64	5.1 ± 1.32	5.35 ± 1.15	5.29 ± 1.05	< 0.001
Severity	4.49 ± 1.51	3.98 ± 1.32	3.9 ± 1.42	3.71 ± 1.73	< 0.001
Positive reinforcement behaviour	4.08 ± 1.5	4.71 ± 1.19	5.05 ± 0.9	4.89 ± 1.09	< 0.001
Negative reinforcement behaviour	3.85 ± 1.7	4.69 ± 1.34	4.83 ± 1.22	4.53 ± 1.49	< 0.001
Self efficacy	77.49 ± 21.71	84.03 ± 56.38	84.42 ± 20.91	87.01 ± 17.67	< 0.001
Outcome expectancies	84.48 ± 14.72	88 ± 9.59	89.81 ± 8.87	91.61 ± 8.8	< 0.001

*non-normally distributed, expressed as median [25th–75th percentile]
BMI — body mass index; BREF — brief; CAD — coronary artery disease; CVA — cerebrovascular accident; HbA1c: glycated hemoglobin; HDL — high-density lipoprotein; LDL —low-density lipoprotein; MDQ — Multi-dimensional Diabetes Questionnaire; PAD — peripheral artery disease; QOL: quality of life; T1DM — type 1 diabetes mellitus; T2DM — type 2 diabetes mellitus; WHO: World Health Organization

Table 3. Co-relation of WHO-QOL-BREF aggregate score with different domains of WHO-QOL-BREF score and MDQ score, with and without adjusting for different variables

Parameter		WHO-QOL BREF aggregate score
		Spearman's correlation coefficient
WHO-QOL-BREF domain score	Physical health	0.661 (< 0.001)
	Psychological	0.818 (< 0.001)
	Social relationship	0.559 (< 0.001)
	Environmental	0.838 (< 0.001)
MDQ score	Interference	–0.070 (0.004)
	Social support	0.283 (< 0.001)
	Severity	–0.170 (< 0.001)
	Positive reinforcement behaviour	0.255 (< 0.001)
	Negative reinforcement behaviour	0.172 (< 0.001)
	Self efficacy	0.267 (< 0.001)
	Outcome expectancies	0.248 (< 0.001)

All values have been expressed as correlation coefficient (p-value in parenthesis); $p < 0.05$ considered statistically significant

Table 4. Regression analysis showing variables that are independent predictors of WHO-QOL-BREF aggregate score in people living with diabetes

Variable	Exp (B) [95% Confidence Interval]	P
Age	0.003 [0.000–0.006]	0.023
Sex	0.064 [0.010–0.119]	0.021
Type of Diabetes	–0.132 [–0.265–0.001]	0.043
Duration of diabetes	0.000 [0.000–0.001]	0.004
Number of medications	0.029 [–0.005–0.063]	0.095
HbA1c	–0.021 [–0.035–0 0.007]	0.003
Hypoglycemia	–0.091 [–0.150 to –0.032]	0.002
Nephropathy	–0.114 [–0.184 to –0.044]	0.001
Neuropathy	–0.078 [–0.141 to –0.015]	0.015
CAD	–0.055 [–0.110 to –0.001]	0.047
PAD	–0.240 [–0.489–0.010]	0.060

Linear regression was initially performed with all parameters, which are likely to influence the WHO-QOL-BREF QOL score [age, sex, body mass index (BMI), type of diabetes, duration of diabetes, number of medications, insulin use, number of insulin pricks per day, HbA1c, lipid parameters, presence of neuropathy, nephropathy, retinopathy, coronary artery disease (CAD), peripheral artery disease (PAD), history of cerebrovascular accident (CVA), hypoglycemia]. Parameters with $p < 0.2$ were included into the final model as elaborated in the table; Exp (B): exponentiation of the B coefficient, change in odds ratio with 1 unit change in the predictor variable

females and males in south Asia, highlighting the high prevalence of central obesity and metabolic syndrome in these individuals. The significantly higher occurrence of hypertension, triglycerides, and the significantly lower LDL-C in people with T2DM again reinforces the predominant phenotype of metabolic syndrome (MetS) and insulin resistance in people with T2DM in New Delhi. The significantly higher age with a longer duration of diabetes may explain the increased occurrence of end-organ damage (neuropathy, retinopathy, and coronary artery disease) in people living with T2DM as compared to T1DM, in spite of a worse glycaemic control in people with T1DM.

A concordant, as well as a statistically significant correlation of different domains of WHO-QOL-BREF questionnaire and MDQ questionnaire with the WHO--QOL-BREF aggregate score, is reflective of the reliability of the QOL assessment using these tools. Interference and severity domains of the MDQ questionnaire assess the negative aspects of QOL, and hence they have a negative correlation with the WHO-QOL-BREF aggregate score.

Increased age and diabetes duration were associated with better QOL in this study. This observation is confounded by the fact that people with T1DM were significantly younger, had significantly lower QOL

Table 5. Key message from different quality of life studies from across the globe

Reference	Country; no. and type of DM	QOL tool used	Key message
[24]	Austria; 223; T2DM	WHO-QOL-BREF	Negative correlation of HbA_{1c} with physical health ($r = –0.31$, $p < 0.001$), psychological ($r = –0.23$, $p < 0.001$), social relationships ($r = –0.15$, $p < 0.005$) and environmental ($r = –0.23$, $p < 0.001$) domains
[25]	Brazil; 92; T1DM adoloscents	Diabetes Quality of Life for Youths questionnaire	Diabetes-related complications ($p = 0.004$), number of hospitalizations ($p = 0.01$), number of daily insulin injections ($p = 0.02$), HbA1c ($p = 0.002$) and triglycerides (p-value = 0.03) associated with greater impairment of QOL
[26]	Austria; 170; T2DM	WHO-QOL-BREF	No significant differences in QOL scores of insulin-treated group vs. OAD group; no impact of SGLT2i on QOL
[27]	Thailand; 502; T2DM	The Thai version of Diabetes-39	Obesity, insulin injection, a combination of insulin & OAD, smoking, foot ulcers predictors of poor QOL
[28]	Canada; 929; T2DM; 27.4% DF	12-item SF PCS, MCS, EuroQol 5-Dimension 5-Level	people with diabetic foot disease reported lower HRQOL at baseline; they had similar changes compared to those without diabetic foot disease during 2-year follow up
[29]	Poland; 197; T1DM	PedsQL Diabetes Module 3.0 questionnaire	Increased waist-hip ratio, hypoglycemia, and female sex were independent predictors of poor QOL
[30]	Poland; 115 T1DM; 215 T2DM	Polish Audit of diabetes-dependent QoL (ADDQoL)	Male gender, depression, lack of freedom to eat and drink were predictors of poor QOL
[31]	Nepal; 102; T2DM	Nepali version of D-39 questionnaire	Age, glycaemic control, diabetes duration, education status were predictors of poor QOL
[32]	Iran; 163; T2DM	SF-36 questionnaire	Smoking; dyslipidemia, hypertension, obesity, worse glycemia were predictors of poor QOL
[33]	Ethopia; 267; T2DM	WHO-QOL-BREF	Age, disease duration, fasting glucose are inversely associated with all domains QOL ($p < 0.001$). BMI is inversely related to all domains except the physical health domain.
[34]	Indonesia; 907; T2DM	EuroQol-5D (EQ-5D) index scores	Predictors of lower QOL scores were treatment in secondary care, lower educational level, dependency on caregivers, not undergoing therapy, and being a housewife
[35]	Switzerland; 585; T2DM	PCS, MCS of SF-12, & diabetes-specific QOL	The lowest QOL scores were for freedom to eat/drink, sex life. Older age, lower income, diabetes for > 10 years associated with lower QoL
[36]	Taiwan; 466; T2DM	QOL assessment at baseline & 6 monthly for 2 years. Latent class growth analysis used to identify QoL trajectory patterns	The "steadily poor" (n = 27, 5.8%), "consistently moderate" (n = 174, 37.3%), and "consistently good" (n = 265, 56.9%) trajectory patterns were identified. HbA1c (OR 1.25) & diabetes distress (OR 1.24) were strongest independent predictors of QOL trajectory patterns
[37]	Ethiopia; 344; T2DM	WHO-QOL-BREF	WHO-QOL-BREF aggregate score was 52.6 ± 12.1. Education, marital status, occupation, diabetes duration & complications had a significant association with QOL
[38]	China; 1958; T2DM	EQ-5D-3L; at baseline and at 12 months	Older age, lower education, & less exercise were significant predictors for worsening in QOL
[39]	Australia; 932; T2DM	SF-12 version 2 PCS, MCS, and AWI score from Audit of Diabetes Dependent QoL QOL assessed biennial over 4 years	Treatment intensification, insulin initiation, does not impact adversely QOL in community-based T2DM. Since insulin use at entry was associated with longer diabetes duration, worse glycemia, greater risk of chronic complications, the burden of DM rather than treatment modality is the primary determinant of QOL
[40]	Malaysia; 180; T2DM	ADDQoL-18	Age, insulin use were predictors of poor QOL
[41]	Japan; 2970; T2DM	Diabetes therapy-related quality of life	Increased physical activity was an independent predictor of good QOL
[42]	Spain	ADDQoL-19 (48 LADA; 297 T2DM; 124 T1DM)	Diabetic retinopathy, insulin use, LADA were independent predictors of poor QOL

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Table 5 (cont.). Key message from different quality of life studies from across the globe

Reference	Country; no. and type of DM	QOL tool used	Key Message
[43]	Finland; 178 T2DM	EuroQol EQ-5D questionnaire	Older age, poor glycemic control were independent predictors of poor QOL
[44]	China; 1275 T2DM	SF-12 and SF-6D questionnaires	Presence of either heart disease, stroke, ESRD, and STDR) was associated with lower QOL
[45]	Portugal; 284; T2DM	SF-36 baseline & after 2 years	Increased exercise but not metformin improved QOL
[46]	Iran; 300; T2DM	WHO-QOL-BREF	Total QOL was influenced by gender, marital status & comorbid renal disease
[47]	UK; 510; T2DM	ADDQoL assessed at baseline & at 5 years	Increases in HbA1c from 1 to 5 years post-diagnosis were independently associated with increased odds of reporting a negative impact of diabetes on QoL
[48]	Spain; 751; T2DM	EQ-5D and ADDQoL	People with poorer metabolic control, previous hypoglycemia, & more complex therapies had worse QoL
[49]	France; 2832; T2DM	SF-12 for MCS & PCS	Older age, female sex, higher BMI, lower income, insulin treatment, macrovascular complications, hypoglycemia, hospitalization ≥ 24 h were predictors of poor QOL
[50]	Singapore; 282; T2DM	Euroqol 5-D	Lack of freedom to eat, higher HbA_{1c} were predictors of poor QOL

AWI — average weighted impact; DF — diabetic foot; DM— diabetes mellitus; ESRD — end-stage renal disease; HC — healthy controls; LADA — latent onset autoimmune diabetes of adult; MCS— mental health component summary; QOL: quality of life; NO — umber; PCS — physical health component summary; SF-36 — short-form health survey 36; STDR — sight-threatening diabetic retinopathy; T1DM — type 1 diabetes mellitus; T2DM — type 2 diabetes mellitus UK — United Kingdom

scores than T2DM; and T1DM was an independent predictor of worse QOL. People with the worst glycaemic control (highest FBG, PPBG, and HbA1c) had the worst/lowest QOL scores in our study, highlighting the importance of good glycaemic control on QOL. Different small studies have reported the adverse impact of poor glycaemic control on QOL in people living with diabetes [8–10]. In a randomized controlled trial involving 1146 patients, over a period of 28 months, people achieving HbA1c < 7%, systolic blood pressure less than 140 mm Hg, and LDL-C less than 130 mg/dl had a much better improvement in health-related quality of life (HRQL) scores [11]. Our study highlighted that people living with T1DM had worse glycaemic control as well as QOL score when compared to T2DM. Data is scanned with regards to QOL in T1DM when compared to T2DM. In a study involving 49 children with T1DM, children with a recent diagnosis, older age at onset, lower maternal educational level, elevated HbA1c had worse QOL scores, as well as more psychologic and cognitive issues [12].

Few studies have suggested people using insulin for diabetes management have worse QOL [9, 10]. In our study, insulin use was significantly higher in people with lower QOL scores. However, this should not lead to the conclusion that insulin use is associated with poorer QOL in people living with diabetes. We must realize that people with more advanced diseases (greater beta-cell loss) are more likely to use insulin. Patients on insulin in our study had a greater burden of end-organ damage and a higher percent of T1DM, which would have contributed to the lower QOL scores. In fact, regression analysis did not reveal insulin used to be an independent predictor of QOL in people living with diabetes. Lack of freedom to eat the food of choice was implicated as a cause for poor QOL in people living with diabetes from Karnataka, India [11]. The presence of MetS, central obesity has been linked with poorer QOL in people living with T2DM from Punjab India [13].

Among the complications of diabetes, the presence of nephropathy had the greatest adverse impact on QOL scores (11.4% reduction), followed by hypoglycemia (9.1% reduction) and neuropathy (7.8% reduction). Increased severity of retinopathy was linked to poorer QOL in a cohort of 97 patients with diabetic retinopathy from Mangalore India [14]. In a study involving 256 T2DM patients from Taiwan, being younger, male sex, more educated with low income, more diabetes complications, and higher HbA_{1c} were predictors of poor QOL [15].

It is important to highlight that the number of medications used for treating diabetes and insulin use was not an independent predictor of QOL scores. Hence it is important to ensure a good glycaemic con-

trol (Hba1c) in people living with diabetes for a better long-term QOL. How we reach this good glycaemic control using what medications is not important. Insulin use was not associated with any impaired QOL, a myth that is quite prevalent among patients living with diabetes in this part of the world [16, 17]. There are even reports available to suggest that insulin use is associated with improvement in QOL scores in people living with diabetes [18, 19]. In fact, delayed insulin initiation in people living with diabetes is associated with prolonged worse glycaemic control, resulting in a greater long-term burden of end-organ damage and worse QOL scores.

Depression, diabetes distress, and QOL are interlinked. Increased occurrence of depression is linked with poor QOL scores in diabetes [6]. Increased burden of end-organ damage contributes both to the burden of depression, diabetes distress, and poor QOL [6]. In a study involving 3170 people with T2DM, a high prevalence of anxiety disorders was noted, the most common being generalized anxiety disorder (8.1%) followed by panic disorder (5.1%). Female gender, presence of complications, longer disease duration, poorer glycaemic control (HbA1c) were significantly associated with the occurrence of anxiety disorders [20]. People from India and Bangladesh were reported to have a lower burden of an anxiety disorder [20]. In a systematic review of 41 studies, the burden of depression in people living with diabetes has been reported to range from 2–7% in T1DM and 8–84% in T2DM with age, female gender, low literacy rate, lower socioeconomic status, marriage, and increased diabetes duration, diabetes-related complications and poor glycaemic control being predictors of depression [21]. Hence the factors which are predictors of QOL are also the predictors of depression, highlighting the close-knit relation between QOL, anxiety disorders, and depression in diabetes. The Diabetes Attitudes, Wishes, and Needs (DAWN2) study highlighted the importance of family support for better outcomes in people living with diabetes [22]. In a cohort of 41557 patients, the presence of diabetes with other non-communicable diseases (NCDs) like stroke has been shown to be associated with much greater health care utilization than each of the conditions alone [23]. Since most of the other NCDs are directly or indirectly related to diabetes, better control of diabetes would have a cascading impact on reducing the burden of other NCDs, overall having a beneficial impact on QOL.

The QOL outcomes of people living with diabetes from different part of the globe have been elaborated in Table 5 [24–50]. Poor glycaemic control, longer disease duration, increased obesity, metabolic syndrome, presence of end-organ damage (especially vision loss, nephropathy, diabetic foot), hypoglycemia were consistently found to be predictors of poor QOL. Among social factors, lack of education, poor socioeconomic status, inability to afford treatment contributed to poor QOL related to diabetes. Among the psycho-emotional factors, lack of freedom to choose what to eat was the most common factor adversely affecting QOL. Associated depression and diabetes distress impaired QOL. Increased exercise and physical activity have been consistently linked with improved QOL in people living with diabetes. The Hypos-1 observational study showed that in a cohort of 2229 people living with diabetes, not only severe but also symptomatic hypoglycemia negatively affect patients' QOL [51]. These studies consistently highlight the importance of good glycaemic control and prevention of end-organ damage (both microvascular and macrovascular complications) in ensuring good QOL in people living with diabetes. Increased exercise, physical activity, and weight loss have a positive impact on QOL. Cognitive behavior therapy to tackle diabetes distress, depression also has a major role in improving QOL.

To summarize, this study highlights that age, sex, type of diabetes, duration of diabetes, and degree of glycaemic control are important independent predictors of QOL among people living with diabetes in India. Younger age, female sex, T1DM, longer disease duration, and worse glycaemic control are important predictors of poor QOL. A greater burden of end-organ damage, both microvascular and macrovascular complications are associated with worse QOL, with nephropathy being the worst predictor. This is the largest ever reported on predictors of QOL among people living with diabetes in India. Predictors of QOL in diabetes in India are similar to that of the rest of the world. Insulin use has no adverse impact on QOL. The number of medications used has no adverse impact on QOL.

Conflict of interest

None declared.

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