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RESEARCH ARTICLE

Association of quality of life with medication adherence and glycemic control in patients with type 1 diabetes

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Abstract

Background and objectives Psychological factors and patients' health-related quality of life (HRQOL) affect the outcome of patients with type 1 diabetes mellitus (T1DM). In this study, we aimed to determine the HRQOL status in patients with T1DM and its association with glycemic control and medication adherence.

Methods In this cross-sectional study, 227 T1DM patients were selected from the diabetes clinic, Imam Ali Hospital, Alborz University of Medical Sciences, and the Gabric database registry from 2020 to 2022. Demographic and diabetes characteristic checklist, medication adherence questionnaire (8-item Morisky Medication Adherence Scale (MMAS)), and QOL questionnaires (Short-Form-12 and PedsQL) were filled. Independent sample T-test was used to assess mean of QOL subscales with glycemic control and medication adherence. A logistic regression model was used to evaluate the association between glycemic control and medication adherence with QOl.

Results Overall QOL scores in adults and children were 33.4 ± 7.1 based on Short-Form-12 and 76.2 ± 17.8 based on PedsQL, respectively. It was demonstrated that adults with Moderate/High adherence had higher QOL (p-value = 0.007). Likewise, Children with good glycemic control had higher psychosocial health scores (0.048). Logistic regression analysis did not reveal a significant association between adherence and QOL or Glycemic control and QOL in both adjusted and crude models.

Conclusion Better glycemic control and medication adherence in children and adults, respectively, are related to the psychological aspects of QOL. We suggest that emotional intelligence, which is replaced by other predictors during adulthood, may contribute to glycemic control in children in the early years following diagnosis.

Keywords Type 1 diabetes mellitus · Quality of life · Medication adherence · Glycemic control

Introduction

Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease caused by the destruction of insulin-producing pancreatic β cells. The worldwide incidence and prevalence of T1DM are approximately estimated to be 15 per 100,000 people and 9.5%, respectively [1]. The increasing trend of T1DM prevalence accentuates the burden it imposes on individual and community health. Although there is no definite cure for T1DM, the advances in insulin analogs designs and the introduction of different technologies aiding glycemic control have transformed patients' outcomes [2].

The strategies to minimize the development of long-term complications in patients with T1DM include delivering insulin to achieve glycemic control, managing cardiovascular risk factors, and ameliorating the psychosocial aspect of patients' lives. Aside from insulin injections and checking

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blood glucose multiple times daily, patients are supposed to follow substantial behavioral modifications [3]. Previous studies have displayed controversial results concerning the impact of T1DM on the quality of life (QOL); therefore, the complex nature of diabetes and its psychological challenges in different settings call for further investigations [4–7]. Moreover, the existing literature on the association between QOL and glycemic control and adherence demonstrates that QOL correlates with glycemic control and adherence [8–11]. While the impact of T1DM on patients' QOL has been studied extensively, and there is existing research on the separate relationship between QOL, medication adherence, and glycemic control, there remains a notable gap regarding the interconnectedness of these factors within the context of T1DM. Comprehensive investigation of how QOL interplays with medication adherence and glycemic control in T1DM patients is crucial for improving patients' outcomes.

Health-related QOL (HRQOL) is a complex concept that evaluates the individual's perception of emotional, physical, and social functioning [12]. Various tools have been developed to standardize this concept, and multiple studies assessed the QOL of patients with T1DM using different types of ques0tionnaires. The Pediatric QOL (PedsQL) and 12-Item Short Form Health Survey (SF-12), used in the present study, are valid and reliable tools used to measure the QOL in patients with T1DM [13, 14].

In the present study, we aim to determine the HRQOL status in patients with T1DM and its association with glycemic control and medication adherence.

Methods

Study settings

The study was conducted in Alborz, Iran, over two years from 2020 to 2022. Data collection primarily took place at the Diabetes Clinic of Imam Ali Hospital and the Gabric database registry. Patients with T1DM were recruited, and various data related to their medical condition, medication adherence, and quality of life were collected. The study's multi-faceted approach involved both children and adults,

Study design

This was a cross-sectional observational study that included patients with T1DM, diagnosed by expert endocrinologists, recruited from the Diabetes Clinic of the Imam Ali Hospital of Alborz and the Gabric database registry between 2020 and 2022. Sample size was determined according to previous study and by considers in type I and II errors 0.05 and 0.2 respectively [11].

This study was reviewed and approved by the ethical committee of Alborz University of Medical Sciences. The aims and methods of the study were explained to the patients or their guardians, and after obtaining their informed consent, the questionnaires were sent to them. The questionnaires were filled by the guardians with their child, in case the patient was younger than ten years old.

Participants

In this study, we included 227 patients with T1DM who were selected from the diabetes clinic at Imam Ali Hospital, Alborz University of Medical Sciences, and the Gabric database registry. The inclusion criteria for the sample consisted of the diagnosis of T1DM diagnosed between 2020 and 2022 who are willing to participate in the research.

Data collection

Patients were assessed through the following questionnaires: demographic information, diabetes characteristics, medication adherence, and QOL assessment questionnaires. In addition, the last HbA1c of patients, tested within the past six months, was extracted from patients' records. According to the Standards of Medical Care in Diabetes published in 2020 [15, 16], the cutoff of 7.5 and 7 were selected for HbA1c in children younger than 18 years old and patients aged 18 and older, respectively.

The medication adherence was evaluated by 8-item Morisky Medication Adherence Scale (MMAS). Laghousi et al. validated the Persian version of 8-item MMAS questionnaire in patients with T2DM [17]. In the present study, patients with scores of 6 and more were considered to be moderate/high adherent; whereas, patients with scores of less than 6 were considered to have low adherence.

The QOL questionnaires included SF-12 for patients aged 18 years or older and PedsQL for patients younger than 18. SF-12 is a valid and reliable HRQOL measure that is a shorter version of the generic SF-36 questionnaire [18]. Individuals with total scores of 37 to 48, 25 to 36, and 12 to 24 were considered to have high, moderate, and low QOL, respectively. PedsQL is a brief measure of HRQOL in children and adolescents, which can be completed by the proxy or children [13]. It is comprised of 23 items that are divided into four subscales: physical health (eight items), emotional functioning (five items), social functioning (five items), and school functioning (five items). Each item is responded on a five-point Likert scale. The total score percentage of less than 25, 25 to 75, and more than 75 are considered low, moderate, and high QOL, respectively.

Table 1 Sociodemographic and diabetes characteristics

Sociodemographic and Diabetes Characteristics		Total
Age, Year; mean (SD)		17.3 (10.6)
Sex; N (%)	Male	96 (42.3%)
	Female	131 (57.7%)
Weight Disorders; N (%)	Underweight	23 (11.7%)
	Normal Weight	116 (58.9%)
	Overweight	38 (19.3%)
	Obese	20 (10.2%)
Socio-Economic Status; N (%)	Low	76 (33.5%)
	Moderate	76 (33.5%)
	High	75 (33.0%)
Duration of Diabetes, years; median (IQR)		4.0 (5.5)
Number of Daily Injections; N (%)	Twice	10 (4.4%)
	Three times	53 (23.3%)
	Four times	76 (33.5%)
	Five time	63 (27.8%)
	More than five times	25 (11.0%)
Injection Device; N (%)	Pen	210 (92.5%)
	Syringe	17 (7.5%)

Statistical analysis

The obtained data were entered into the SPSS version 26.0 (SPSS Inc., IBM Company). Categorical and continuous variables were demonstrated as frequency (percentage) and mean (standard deviation (SD)), respectively. The Chi-square test was used to display the association between categorical variables. Normal distribution of continuous variables was assessed using Kolmogrov-Smirnov test. Independent sample T-test was used to assess mean of QOL subscales with glycemic control and medication adherence. The association between glycemic control and medication adherence with high QOL was evaluated using univariate and multivariate logistic regression model. The results of logistic regression analysis were presented as odds ratio (OR) and 95% confidence interval (CI). A P-value of less than 0.05 was considered statistically significant.

Results

A total of 227 patients were included in the present study, among which 42.3% were male. The mean ± SD age of the participants was 17.2 ± 10.6 years, and the median (IQR) duration of diabetes was 4.0 (5.5) years. The sociodemographic and diabetes characteristics of patients are presented in Table 1.

Overall, among patients younger than 18 years, the mean ± SD of the total QOL score and its physical and psychosocial sub-scores were 76.2 ± 17.8, 77.8 ± 21.0, and 75.4 ± 18.3, respectively. Additionally, the mean ± SD of the total QOL score and its physical and mental sub-scores in patients aged 18 years or older were 33.4 ± 7.1, 16.0 ± 2.7, and 17.3 ± 5.4, respectively. Regarding medication adherence, 51.5% of all patients had moderate/high adherence, and 48.5% had low adherence. Also, the mean ± SD of HbA1c was 8.2 ± 1.7.

According to Table 2, an assessment of the association between QOL and adherence in patients younger than 18 years old demonstrated that the QOL and its subscales scores were not significantly different between moderate/high and low adherence patients. On the other hand, psychosocial health score and its subscale, school functioning, were significantly higher in patients with good glycemic than those with poor glycemic control.

Table 3 shows that in patients with T1DM aged 18 years or older, although there is no significant association between QOL scores and glycemic control groups, significantly higher total QOL and mental health scores were observed in patients with moderate/high compared to those with low adherence.

Table 2 The association between glycemic control, adherence (MMAS-8), and quality of life in patients with T1DM aged < 18 years

Pediatric Quality of Life Scores; Mean (SD)	Glycemic Control			Adherence (MMAS-8)		
	Poor	Good	P-value	Low	Moderate/High	P-value
Total Pediatric Quality of Life	75.6 (17.2)	82.8 (16.7)	0.100	75.6 (13.9)	76.7 (20.2)	0.741
Physical Health	80.1 (17.1)	83.2 (21.3)	0.519	78.5 (17.0)	77.2 (23.4)	0.728
Psychosocial Health	73.2 (19.6)	82.5 (15.3)	**0.048**	74.1 (15.0)	76.3 (20.2)	0.478
Emotional Functioning	62.8 (23.3)	72.4 (25.1)	0.116	61.8 (23.5)	65.7 (22.9)	0.327
Social Functioning	84.6 (23.0)	88.9 (12.2)	0.402	84.9 (17.3)	86.6 (21.0)	0.619
School Functioning	72.2 (24.5)	86.3 (15.2)	**0.013**	75.5 (16.9)	76.7 (24.6)	0.766

Table 3 The association between glycemic control, adherence (MMAS-8), and quality of life in patients with T1DM aged ≥ 18 years

Adult Quality of Life Scores; Mean (SD)	Glycemic Control			Adherence (MMAS-8)		
	Poor	Good	P-value	Low	Moderate/High	P-value
Total Quality of Life	34.3 (6.9)	34.0 (5.8)	0.911	31.8 (7.5)	36.1 (5.4)	**0.007**
Physical Health	15.8 (2.6)	16.5 (2.1)	0.508	15.6 (2.9)	16.8 (2.1)	0.065
Mental Health	18.5 (5.5)	17.5 (4.3)	0.646	16.2 (5.7)	19.4 (4.3)	**0.010**

Logistic regression models determined the association of the QOL groups with medication adherence and glycemic control groups in Table 4. The findings demonstrated that patients with moderate/high adherence compared to those with low adherence were not associated with high QOL, regardless of adjustment to age, sex, weight group, and SES. Similar results were found in crude and adjusted models evaluating the association between the glycemic control and QOL groups.

Discussion

The current cross-sectional study demonstrates that enhanced psychological aspects of the QOL are linked with better glycemic control, and medication adherence in children and adults, respectively. Nevertheless, we did not illustrate any other significant association between other components of QOL and diabetes-related indices.

In other words, we showed that psychosocial health scores of QOL are notably higher in T1D pediatrics with better glycemic control. It should be considered that glycemic control is a well-established predictor of short-term and long-term adverse outcomes of T1D [19, 20]. Studies proved that poor glycemic control is a significant contributor to higher mortality in pediatrics [21].

To address this issue several studies have been conducted to identify the predictors of enhanced glycemic control. Formerly, scientists believed that had patients only been prescribed a more potent drug, they would have improved outcomes [22–24].

Table 4 The association between the quality-of-life categories, high/moderate adherence, and good glycemic control in logistic regression model

Glycemic Control and Adherence Categories	High Pediatric Total Quality of Life	High Adult Total Quality of Life
	OR [c] (95% CI)	OR [c] (95% CI)
High and Moderate Adherence/ Low Adherence		
Model I [a]	0.70 (0.35–1.42)	0.51 (0.20–1.32)
Model II [b]	0.79 (0.35–1.79)	0.49 (0.17–1.42)
Good Glycemic Control/ Poor Glycemic Control		
Model I [a]	0.63 (0.21–1.88)	0.67 (0.14–3.19)
Model II [b]	0.98 (0.27–3.60)	1.10 (0.14–8.57)

[a] Crude model

[b] Adjusted for sex, age, weight disorder, type of insulin injection, regimen and SES

[c] odds ratio

Nevertheless, recent studies identified that indices such as concurrent dyslipidemia, lower compliance, and lower educational and socioeconomic status of parents are also tightly contributed to the glycemic control of patients [25, 26]. Additionally, the current study reveals concomitance of psychological health and enhanced glycemic control.

The concomitance of psychological health and improved glycemic control can be justified by the mediation role of variables such as self-efficacy and adherence behaviors [27], although the current study did not show a significant link between medication adherence and glycemic control in children. This might be due to the fact that medication adherence needs time to develop. That is to say, as the current study is designed cross-sectionally, we might not give sufficient time to children to develop medication adherence [28, 29].

Alternatively, the correlation between psychological health and glycemic control can be mediated by other variables in Iranian children. Studies proved that patients, especially adolescents, diagnosed with diabetes are at higher risk of depressive, and anxiety symptoms, known as diabetes distress [30, 31], which is correlated to emotional intelligence in adolescents, but not in adults [32].

Recently, Baszyńska-Wilk et al. showed that emotional intelligence, which is defined by the ability to utilize emotions, considerably influences the metabolic outcomes of patients with T1D [33]. In parallel, the Tavakol Moghadam et al. study which was conducted at Shahid Motahari Diabetes Center, Shiraz, Iran, showed that emotional intelligence is correlate to the hemoglobin A1c (HbA1c) level, an important parameter in the control of diabetes in adolescents [34]. As higher emotional intelligence is closely correlated to higher QOL scores, especially in teenagers [35], it might be the mediator between psychological health and glycemic control [36, 37]. By way of explanation, this study proposes a probable novel pathway that indicates that patients with poor glycemic control are attributed to have lower emotional intelligence, and consequently lower psychological QOL and school functioning.

Interestingly, the condition of adults recruited in the current study is quite the opposite. Adults with lower QOL scores have a notable lower medication adherence, while no correlation is seen between QOL and glycemic control. Notably, only less than 8% of T1D patients are diagnosed when they were 15 years of age or more [38]. As patients become older, they pass the first years of being diagnosed with diabetes, and consequently the impact of initial shock decreases. In other words, patients get adapted to diabetes, regardless of their ability to utilize emotions (emotional intelligence). This transformation attenuates the association between the mental aspect of QOL and diabetes distress with glycemic control [39, 40].

Instead, the experience of living with diabetes increases patients' overall knowledge about the disease and its consequences [41]. Even though knowledge is necessary for the establishment of adherence, it is not sufficient and other components are required for the establishment of adherence. For instance, patients with healthier mental health have better odds to transform their knowledge to the establishment of medication adherence [42, 43]. This is consistent with our study that showed a significant link between mental health and QOL with adherence in adults.

The current study's findings emphasize the need for targeted interventions that take the age and psychological well-being of patients with T1DM into account. For pediatrics diagnosed with diabetes, interventions that focus on emotional intelligence and psychosocial support may be beneficial in improving glycemic control. However, for adults, the objective of interventions should be enhancing mental health and providing education and support to improve medication adherence. These insights assist healthcare providers and researchers in developing more effective strategies to enhance the quality of life and overall health outcomes for individuals with T1DM.

Our study included a wide age range of patients, including children and adults with T1DM. We demonstrated that findings among children may not necessarily apply directly to adults and vice versa. However, It should be noted that the relationship between QOL, medication adherence, and glycemic control may vary at based on several other factors. For instance, cultural and socioeconomic factors play a significant role in managing chronic conditions like T1DM. Our study was conducted in a specific cultural context, and cultural norms, beliefs, and socioeconomic conditions may influence QOL, adherence, and glycemic control. Healthcare systems, clinical practices, and resource access can vary substantially across different healthcare settings.

The study has several limitations to consider. Firstly, its cross-sectional design restricts its ability to establish causal relationships. Secondly, the sample was drawn from a single center and a database registry, potentially introducing selection bias. Additionally, the use of self-reported questionnaires for assessing medication adherence and quality of life may make the data susceptible to recall and social desirability biases. Furthermore, the assessment tools employed to measure QOL might not include all relevant aspects. Although we designed an adjusted model that considered variables such as sex, age, weight disorder, type of insulin injection, regimen, and SES, there is a possibility that unaccounted confounding variables may still influence the results.

Conclusion

Psychological aspects of the QOL are linked with better glycemic control, in children and adults, respectively. We believe that emotional intelligence may play a role in glycemic control in children in the first years after diagnosis, which is replaced by other components during adulthood. Furthermore, higher QOL and mental health are required for the establishment of medication adherence.

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Declarations

Ethics approval The study was approved by the ethical committee of Alborz University of Medical Sciences.

Conflict of interest The authors declare no conflict of interest.

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