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ORIGINAL RESEARCH

Quality of Life and Glucose Regulation in Pediatric Patients with Type 1 Diabetes: A Study in the Ningxia Hui Autonomous Region

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Objective: In this study, we aimed to evaluate the current status of the quality of life (QOL) of pediatric patients and plasma glucose concentration regulation in children with type 1 diabetes (T1DM) in the Ningxia Hui autonomous region.

Methods: The study involved children with T1DM admitted to the General Hospital of Ningxia Medical University between October 2011 and October 2021. The children and their parents completed general information and quality of life (QOL) questionnaires. The regulation of plasma glucose concentration was assessed based on HbA1c levels, and plasma glucose and QOL-influencing components were investigated.

Results: Among the 136 pediatric patients diagnosed with T1DM, the mean glycated hemoglobin (HbA1c) level was recorded at 8.7% (7.2%, 10.5%). A breakdown of the patient cohort revealed that 44 patients (32.4%) demonstrated good regulation of plasma glucose, 33 patients (24.3%) exhibited acceptable glycemic control, and 59 patients (43.3%) displayed poor regulation of plasma glucose. The control of plasma glucose in pediatric patients diagnosed with T1DM was affected by the duration of the disease, the patient's age, the frequency of daily plasma glucose measurements, the use of CGM, diabetic ketoacidosis (DKA), and the education level of the mother. The control of plasma glucose, dietary management, DKA, the ability to learn, and health education are interfering factors of quality of life in children diagnosed with T1DM. Effective control of plasma glucose may ensure the QOL in children with T1DM, and DKA was the risk factor for QOL.

Conclusion: In Ningxia, the regulation of plasma glucose in pediatric and adolescent patients with T1DM remains suboptimal, leading to poor QOL. There is a pressing need to enhance glucose regulation and QOL through comprehensive strategies, which include reinforced dietary management, rigorous monitoring of plasma glucose levels, and heightened health education levels.

Keywords: current status of regulation of plasma glucose concentration, influencing factors, QOL, type 1 diabetes

Introduction

Type 1 diabetes mellitus (T1DM) is a prevalent chronic metabolic disorder observed predominantly in children and adolescents.[1] This disease emerges due to the immune-driven selective obliteration of pancreatic β-cells, influenced by both genetic predispositions and environmental factors. Characterized as an autoimmune disease, it results in absolute insulin deficiency.[2] In many developed nations, patients diagnosed with T1DM constitute approximately 90% of the pediatric and adolescent diabetic population, and an upswing in cases among the youth continues to be reported.[3,4] Clinical presentations of T1DM can be severe and include rapid onset of ketoacidosis, hyperosmolar hyperglycemic states, and lactic acidosis. Prolonged suboptimal glucose regulation can pave the way for microvascular complications such as diabetic retinopathy, neuropathy, and nephropathy, along with macrovascular ailments like coronary artery disease and peripheral vascular disorders.[5] Given the early onset in pediatric populations, these patients are at an elevated risk of acute and chronic complications across multiple organ systems. These complications, in turn,

significantly affect the health and quality of life (QOL) of pediatric patients, thereby imposing economic and societal burdens on their families.[6] Existing studies underscore the pivotal role of efficacious diabetes management in preserving optimal QOL, stalling the progression of complications, and curtailing treatment costs.[7–9] Therefore, along with refining glucose regulation and curtailing complications, it is imperative to enhance the QOL and prognosis.

Currently, mean glycated hemoglobin (HbA1c) levels are recognized as the definitive standard for evaluating plasma glucose regulation. Noteworthy associations have been unearthed between QOL and HbA1c levels in pediatric patients diagnosed with T1DM. A study by Frøisland et al elucidated a direct correlation between deteriorated QOL and elevated HbA1c levels.[10] In a similar vein, Rechenberg et al explored correlations between plasma glucose control, self-care practices, and familial income brackets.[11] Their findings underscored significantly reduced HbA1c levels in children and adolescents from affluent backgrounds compared to their counterparts from lower and middle-income families, thereby underscoring the intricate nexus between HbA1c levels and QOL. Furthermore, empirical data suggests that chronic T1DM can precipitate considerable psychological strain on affected children, manifesting in debilitating emotional responses like anxiety and depression, which severely impinge on their QOL.[12]

While international research landscapes are replete with studies focusing on the QOL of patients diagnosed with T1DM, there are few studies in China regarding this domain. The present study endeavors to assess both QOL and plasma glucose regulation in pediatric patients diagnosed with T1DM, concurrently dissecting the salient influencing factors. By enhancing disease awareness, optimizing glucose regulation, and assessing patient QOL, this study seeks to lay the groundwork for refined therapeutic strategies for pediatric T1DM, ultimately enhancing patient QOL.

Materials and Methods

Participants
The study involved children diagnosed with T1DM admitted to the General Hospital of Ningxia Medical University between October 2011 and October 2021.

Diagnostic Criteria
As stipulated in the "Expert Consensus on the Standardized Diagnosis and Management of Type 1 Diabetes Mellitus in Chinese Children (2020)", a diagnosis of diabetes mellitus can be affirmed if any of the following criteria are met:[13]

(1) A fasting blood glucose level equal to or exceeding 7.0 mmol/L.
(2) An oral glucose tolerance test (OGTT) result showing 2-hour postprandial glucose (2h PG) level equal to or exceeding 11.1 mmol/L. This is based on the administration of glucose at a dosage of 1.75 g/kg of body weight, with the maximum glucose quantity capped at 75 g.
(3) An HbA1c value equal to or exceeding 6.5%, ascertained using the NGSP-certified HbA1c assay. (4) A random blood glucose measurement equal to or exceeding 11.1 mmol/L, coupled with the manifestation of symptoms and signs indicative of diabetes mellitus. It is imperative to reiterate that for asymptomatic individuals meeting the aforementioned criteria, a confirmatory diagnosis should be sought by reevaluating on the subsequent day.

Inclusion Criteria
(1) Children with confirmed T1DM.
(2) Age > 4 years on diagnosis.
(3) Course > 6 months.
(4) Informed consent from guardian of pediatric patient.

Exclusion Criteria
(1) Concomitant other endocrine diseases.
(2) Dysnomia or other mental disorder.
(3) Dropout or those having incomplete data.

Methods

(1) Employing the established inclusion and exclusion criteria, children with T1DM admitted to the General Hospital of Ningxia Medical University between October 2011 and October 2021 were recruited for the study. Guardians of these pediatric patients provided informed consent. This study was approved by the Ethics Committee of the hospital.

(2) Comprehensive data pertaining to the pediatric patients were collated, encompassing: age, gender, duration of disease, treatment regimen, frequency of plasma glucose monitoring, dietary management, health education, continuous glucose monitoring (CGM) usage, HbA1c levels, incidents of diabetic ketoacidosis (DKA), average daily exercise durations, educational level of the mother, and the ability to learn of the patients.

(3) Both the patients and their parents were invited to complete the "Questionnaire on Quality of Life of Children and Adolescents with Diabetes Mellitus in Chongqin", a tool devised by Prof. Zheng Lingling using cluster analysis.[14] It includes two major areas: one is the area of influence (39 questions) and the other is the area of satisfaction (16 questions). The influence area is divided into five areas: interpersonal relations, daily life, psychology, spirit, and physiology. A higher score on this questionnaire corresponds to a superior QOL.

Collection and Data Entry

Patients and guardians jointly completed the questionnaire. Data were independently entered by two persons, which were then cross-checked to ensure accuracy.

Statistical Analysis

All collected data were analyzed utilizing the SPSS 26.0 software package. Descriptive statistics for the general demographic details of the participants are represented as case numbers (n) and percentages (%). Given that neither glycated hemoglobin levels nor QOL scores followed a normal distribution, they are expressed using median values accompanied by their respective quartiles. To discern the factors impacting the plasma glucose levels and QOL, both nonparametric tests and logistic regression analyses were employed. The Pearson's correlation analysis was used to determine relationships between various parameters, with $P < 0.05$ indicating statistical significance.

Results

General Information

A total of 145 questionnaires seeking information on patient demographics were disseminated. Out of these, 136 were returned, reflecting a response rate of 93.8%. From the pool of pediatric patients diagnosed with T1DM who participated, 61 were males (constituting 44.9% of the total) while 75 were females (representing 55.1% of the total). Age-wise distribution was as follows: 5 patients (3.7%) were aged 6 years or below, 90 patients (66.2%) fell in the 6 to 14-year age bracket, and 41 patients (30.1%) were aged above 14 years. Notably, a significant majority, totaling 108 patients or 79.4% of the sample, were administered treatment via continuous subcutaneous insulin infusion (CSII). Comprehensive details can be found in Table 1.

Status Quo of Regulation of Plasma Glucose in Patients Diagnosed with T1DM

Brief Description of Regulation of Plasma Glucose

For the 136 pediatric patients diagnosed with T1DM, the median HbA1c level was recorded at 8.7%, with an interquartile range spanning from 7.2% to 10.5%. When analyzing the plasma glucose regulation, 44 patients (32.4%) demonstrated good regulation, as evidenced by their HbA1c levels being below 7.5%; 33 patients (24.3%) exhibited acceptable regulation, with HbA1c levels ranging from 7.5% to 9.0%; and 59 patients (43.3%) manifested poor regulation, as their HbA1c levels exceeded 9.0%. It is pertinent to note that an HbA1c level of 9.0% or below was deemed indicative of effective plasma glucose regulation. Conversely, an HbA1c value surpassing 9.0% was categorized as indicative of failed regulation.

Table 1 Analysis of Factors Influencing Plasma Glucose Regulation in Children Diagnosed with T1DM (M (P_{25}, P_{75}))

Factors		Number of Cases	HbA1c (%)	Z/H	P
Gender	Male	61	8.70 (6.90, 10.60)	−0.508	0.612
	Female	75	8.70 (7.30, 10.50)		
Disease duration	≤ 2 years	36	7.10 (6.30, 7.98)	48.448	<0.001
	2–5 years	60	8.70 (7.23, 9.78)		
	5–10 years	31	10.50 (9.30, 11.60)		
	> 10 years	9	11.30 (9.45, 11.90)		
Age	≤ 6 years	5	6.30 (5.85, 7.00)	18.847	<0.001
	6–14 years	90	8.50 (7.20, 9.70)		
	> 14 years	41	9.90 (8.35, 11.45)		
Protocol of parenteral insulin	Insulin pump	108	8.70 (7.20, 10.33)	5.675	0.059
	3 times	12	7.30 (6.53, 9.50)		
	4 times	16	10.05 (7.53, 11.70)		
Number of daily measurements of plasma glucose	≤ 2 times	41	10.40 (8.45, 11.60)	19.794	<0.001
	2–4 times	67	7.60 (6.80, 9.70)		
	> 4 times	28	8.60 (7.10, 9.38)		
Use of CGM	Yes	52	7.90 (6.90, 9.30)	−2.842	0.004
	No	84	9.45 (7.33, 10.88)		
Duration of physical exercise	≤ 1 h	49	9.00 (7.30, 10.45)	5.949	0.051
	1–2 h	69	8.10 (7.00, 10.05)		
	> 2 h	18	9.95 (8.48, 11.53)		
DKA	Yes	94	9.00 (7.28, 10.93)	−2.207	0.027
	None	42	8.10 (7.05, 9.70)		
Cost per month	≤ 2000 (RMB)	51	9.50 (7.30, 11.60)	5.390	0.068
	2000–5000 (RMB)	59	8.70 (7.30, 10.00)		
	> 5000 (RMB)	26	7.45 (6.65, 10.13)		
Education level of mother	Primary school and below	39	9.00 (7.40, 10.70)	11.600	0.003
	Middle school and high school	66	9.35 (7.30, 10.83)		
	Higher education and above	31	7.30 (6.40, 8.90)		

Note: *P* < 0.05 indicates statistical significance.

Regulation of Plasma Glucose of Groups of Age

All 5 patients younger than 6-years of age had effective glycemic management; good, moderate, and poor regulation of plasma glucose were reported in 31 cases, 28 cases, and 31 cases, respectively, among 90 patients aged 6 to 14 years; 8 out of 41 patients older than 14 years were found to have good regulation of plasma glucose, 5 had acceptable regulation, and 28 had poor regulation. Details are illustrated in Figure 1A.

Regulation of Plasma Glucose Based on Disease Duration

For patients with a disease duration of ≤ 2 years (36 cases), 22 patients demonstrated good regulation, 9 patients revealed acceptable regulation, and 5 patients displayed poor regulation. In the patients with a disease duration spanning from 2 to 5 years (60 cases), 20 patients had good regulation, 18 patients manifested acceptable regulation, 22 patients evidenced poor regulation. For those with a disease course of 5 to 10 years (31 cases), only 2 patients achieved good regulation, 5 patients had acceptable regulation, while 24 patients displayed poor regulation. Among the longest duration category, with patients having a disease course exceeding 10 years (9 cases), 1 patient exhibited acceptable regulation, while the remaining 8 patients manifested poor regulation of plasma glucose. A comprehensive visual delineation of these findings, segmented by the duration of T1DM, is provided in Figure 1B.
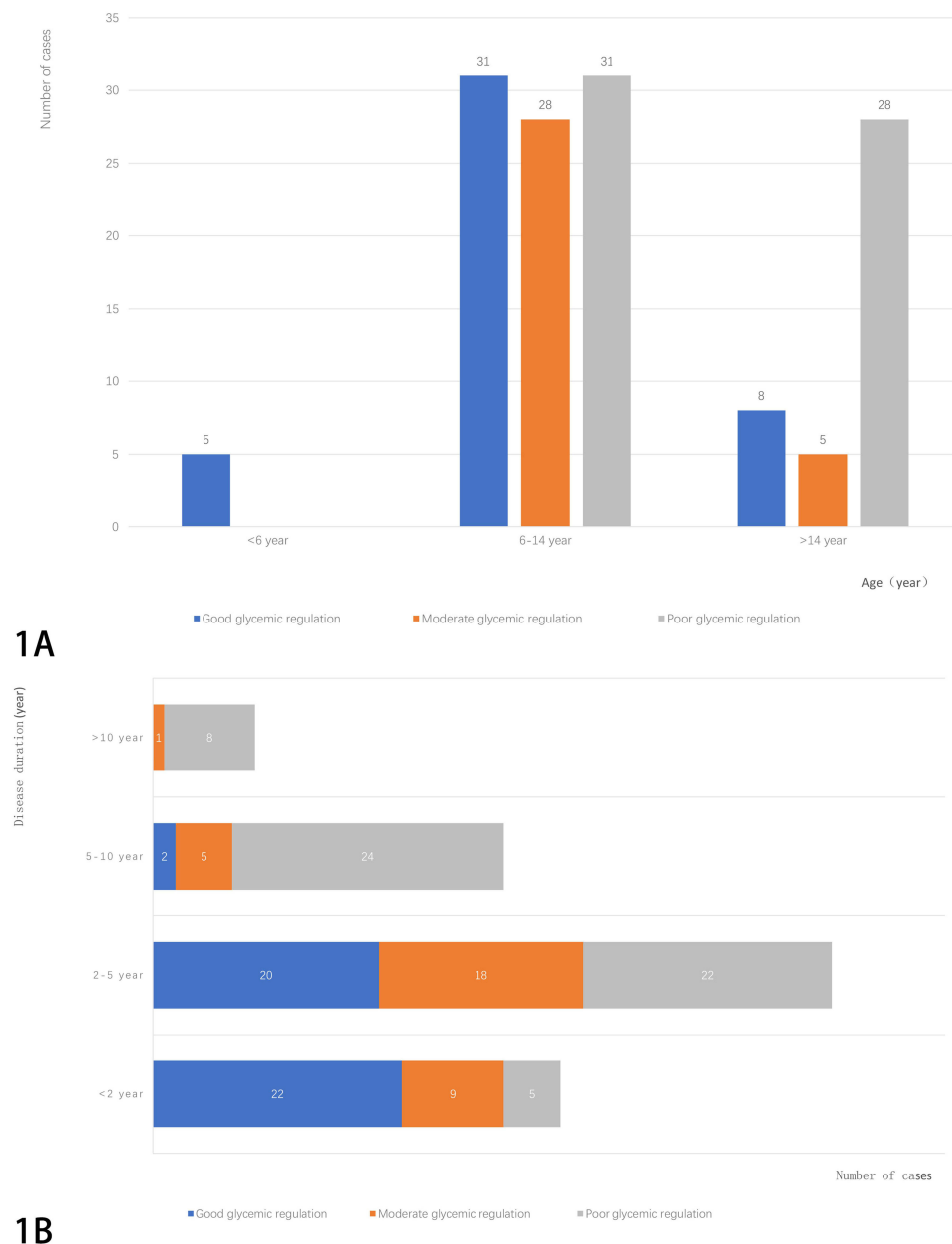
1A

1B

Figure 1 Age interval of children with T1DM (**A**), Regulation of plasma glucose in groups based on disease course (**B**).

HbA1c Distribution Based on Different Dosing Protocol

For the cohort of 108 patients undergoing continuous subcutaneous insulin infusion (CSII) therapy, the HbA1c value was reported as 8.7%, with an interquartile range from 7.2% to 10.3%. Conversely, for the 28 patients treated with multiple daily injections (MDI), the HbA1c value stood at 9.1% with an interquartile range spanning from 7.1% to 11.3%. Upon statistical comparison of the HbA1c distributions between the two treatment modalities, no statistically significant variance was observed (P > 0.05).

Analysis of Factors Affecting Regulation of Plasma Glucose in Children Diagnosed with T1DM

Based on the univariate analysis, the factors include the disease course (P < 0.001), age (P < 0.001), plasma glucose monitoring times daily (P < 0.001), use of CGM (P = 0.004), use of DKA (P=0.027), and education level of mother (P=0.003).
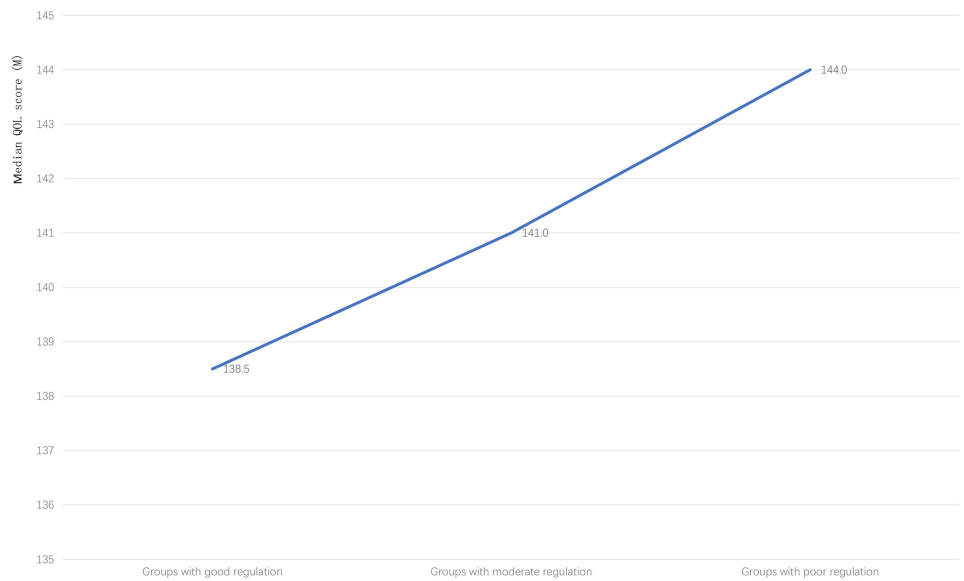
Figure 2 Median QOL score of children diagnosed with T1DM in groups based on of plasma glucose regulation.

Survey on QOL

Results are as follows: The comprehensive assessment of the QOL yielded scores of 141.0 (128.3, 153.0) for children diagnosed with T1DM, 50.5 (45.0, 62.8) for satisfaction, and 90.0 (82.3, 98.0) for impact. The scores for the impact on interpersonal relationship, daily activity, mental state, and physiological activities were 13.0 (10.0, 15.0), 16.0 (13.0, 19.8), 24.0 (21.0, 27.0), 26.0 (22.0, 30.0), 11.0 (9.0, 13.0) respectively.

QOL for Different Plasma Glucose Regulation Levels

The QOL scores were 138.5 (124.0, 143.0), 141.0 (133.5, 151.0), and 144.0 (127.0, 173.0) for the groups with good, acceptable, and poor regulation, indicating significant difference in score among the three groups (P = 0.039). Figure 2 displays the line chart of the median QOL score (M) for the groups based on plasma glucose regulation.

Impact of Plasma Glucose Regulation on Impact, Satisfaction, and Overall Score in Children Diagnosed withT1DM

In comparison to the group with poor regulation of plasma glucose, the group with effective regulation of plasma glucose had significantly lower scores for the impact on interpersonal relationships (P = 0.002), daily activities (P = 0.033), mental state (P = 0.007), and physiological activities (P = 0.036), impact of treatment on patients in 5 aspects (P = 0.003), impact of treatment on patients (P < 0.001), and overall score (P = 0.041). Although the QOL was greater in the group with successful glucose regulation compared to the group with poor glucose regulation, there was no significant difference in satisfaction between the two groups (P = 0.757). The detailed information is provided in Table 2 and Table 3.

Table 2 Impact of Plasma Glucose Regulation on Influence, Satisfaction, and Overall Score in Children Diagnosed with T1DM

Group	Influence	Satisfaction	Overall Score
Group of effective regulation	86.0 (81.0, 95.0)	52.0 (46.0, 62.0)	139.00 (128.5, 147.5)
Group of non-effective regulation	96.0 (87.0, 109.0)	50.00 (40.0, 64.0)	144.00 (127.0, 173.0)
Z	−4.073	−0.310	−2.044
P	<0.001	0.757	0.041

Note: *P* < 0.05 indicates statistical significance.

Table 3 Influence of Plasma Glucose Regulation on Different Aspects

Group	Impact on Interpersonal Relationship	Impact on Daily Activity	Impact on Mental Status	Impact on Physiological Activity	Impact on Pediatric Patient
Group of effective regulation (n=77)	12.0 (9.0, 14.0)	15.0 (13.0, 19.0)	24.0 (19.0, 26.0)	25.0 (22.0, 28.0)	11.0 (9.0, 12.0)
Group of non-effective regulation	14.0 (11.0, 16.0)	17.0 (14.0, 21.0)	24.0 (23.0, 28.0)	26.0 (24.0, 34.0)	12.0 (10.0, 14.0)
Z	−3.069	−2.136	−2.706	−2.094	−2.930
P	0.002	0.033	0.007	0.036	0.003

Note: $P < 0.05$ indicates statistical significance.

Pearson's Correlation Analysis on Sub-Scores of QOL and HbA1c

There was a significant correlation between the HbA1c and the following: QOL score (rimpact = 0.431, P < 0.001), score of impact with respect to 5 aspects (rinterpersonal relationship = 0.254, P = 0.003; rdaily activities= 0.228, P = 0.008; rmental status = 0.336, P < 0.001; rphysiological activities = 0.349, P < 0.001; rimpact on pediatric patient = 0.343, P < 0.001) and overall score (roverall= 0.300, P < 0.001).

Univariate Analysis of QOL of Children with T1DM

Univariate analysis revealed that the factors influencing the QOL in children with T1DM were plasma glucose regulation (P = 0.041), diet management (P = 0.041), DKA (P = 0.046) and health education (P = 0.046). Details are listed in Table 4.

Univariate Analysis of QOL of Children Diagnosed with T1DM

The overall QOL score was compared with the median value of 141.0 by transforming the score into a binary variable. If the QOL score of a patient was below this median, it was classified as "low". Conversely, scores exceeding the median were deemed "high". A binomial logistic regression analysis was conducted using these binary classifications. Based on the results of the analysis, effective regulation of plasma glucose was positively associated with the maintenance of a satisfactory QOL in children diagnosed with T1DM (P = 0.017, OR = 0.389, 95% CI: 0.179–0.843), and DKA was the risk factor for the QOL of children with T1DM (P = 0.034, OR = 2.424, 95% CI: 1.068–5.504). Details are provided in Table 5.

Table 4 Descriptive Analysis of QOL in Children Diagnosed with T1DM (M (P25, P75))

Factors		Number of Cases	Overall QOL Score	Z/H	P
Regulation-based grouping	Effective regulation	77	139.00 (128.50, 147.50)	−2.044	0.041
	Non-effective regulation	59	144.00 (127.00, 173.00)		
Disease duration	≤ 2 years	36	141.00 (128.75, 149.75)	1.538	0.673
	2–5 years	60	141.00 (132.00, 148.75)		
	5–10 years	31	144.00 (118.00, 173.00)		
	> 10 years	9	163.00 (118.50, 208.50)		
Diet management	Directed regulation insulin	10	154.50 (139.50, 180.75)	6.392	0.041
	Parents	116	141.00 (128.00, 153.00)		
	Dietitian	10	134.50 (123.75, 142.00)		
DKA	Yes	94	143.00 (131.00, 157.25)	−1.998	0.046
	None	43	137.00 (128.00, 144.75)		
Education level of mother	Primary school and below	39	143.00 (132.00, 158.00)	0.603	0.740
	Middle school and high school	66	141.50 (126.50, 152.25)		
	Higher education and above	31	141.00 (131.00, 149.00)		
Learning ability	Good	30	134.50 (119.00, 146.25)	6.745	0.034
	Moderate	89	143.00 (132.00, 160.00)		
	Low to moderate	17	142.00 (129.50, 144.00)		
Health education	Staff member for pump assembly	14	130.50 (113.00, 145.25)	6.616	0.037
	Learning via internet	63	144.00 (133.00, 160.00)		
	Physician	59	140.00 (128.00, 151.00)		

Note: $P < 0.05$ indicates statistical significance.

Table 5 Multivariate Analysis of QOL in Children Diagnosed with T1DM

Independent Variable	β	SE	Wald	P	OR	95% CI
Effective regulation of plasma glucose	−0.945	0.395	5.720	0.017	0.389	0.179–0.843
Diet management (1)	−1.362	1.064	1.638	0.201	0.256	0.032–2.062
Diet management (2)	−0.845	0.751	1.268	0.260	0.430	0.099–1.870
DKA	0.885	0.418	4.479	0.034	2.424	1.068–5.504
Health education (1)	0.181	0.661	0.075	0.784	1.198	0.328–4.376
Health education (2)	−0.566	0.407	1.932	0.165	0.568	0.255–1.261

Abbreviations: β, Regression coefficient; SE, Standard error; OR, Odds ratio; 95% CI, 95% Confidence interval.

Discussion

The current therapeutic approach to T1DM aims to maintain optimal plasma glucose regulation and delay or prevent the onset of complications. HbA1c serves as the benchmark for assessing plasma glucose regulation. For pediatric patients diagnosed with T1DM, an HbA1c level below 7.5% is targeted.[15] However, data spanning the past decade has shown an elevation in HbA1c levels from 7.8% (2010–2012) to 8.4% (2016–2018), indicating no significant improvement in plasma glucose regulation.[16,17] In China, more than half of the younger demographic struggles to maintain acceptable plasma glucose levels.[18] Of the 136 surveyed children diagnosed with T1DM, plasma glucose regulation results were as follows: 44 (32.4%) had good regulation, 33 (24.3%) had acceptable regulation, and 59 (43.3%) had poor regulation. This clearly portrays a significant challenge in regulating plasma glucose in pediatric patients diagnosed with T1DM in Ningxia.

Multiple factors could contribute to this. The secretion of growth hormone during puberty can induce insulin resistance, affecting plasma glucose regulation.[19] Younger patients often face challenges with compliance and self-management due to their age, impacting diet management among other factors. Over an extended treatment period, caregivers and parents may develop negative attitudes, given the myriad precautions and challenges they confront, exacerbating the disease complications. Moreover, our study noted a trend where plasma glucose regulation deteriorated as the duration of the disease increased. In patients with a disease history exceeding 10 years, regulation was primarily poor. The shorter the disease course, the less the HbA1c, which is consistent with the results reported by Malerbi et al.[20]

Although parenteral insulin remains the primary therapeutic intervention for pediatric patients diagnosed with T1DM, treatment should be tailored to the patient, accounting for their age, physiological state, and daily routine. While CSII is commonly adopted by around 63% of pediatric patients diagnosed with T1DM in the USA and 5–15% in Europe, research by Pickup et al indicated that CSII enhanced plasma glucose regulation in pediatric patients diagnosed with T1DM.[17,21,22] In our study, although CSII was linked with a slightly lower median HbA1c than MDI, the difference was not statistically significant, potentially due to the underrepresentation of MDI-receiving children.

Plasma glucose regulation is influenced by a plethora of factors. Our study identified several factors affecting this in pediatric patients diagnosed with T1DM, including the duration of the disease, patient age, frequency of plasma glucose monitoring per day, CGM, DKA, and the educational level of the mother.

Aeppli et al discovered that pediatric patients aged between 0 to 4 years exhibited effective regulation of plasma glucose within a span of five years post-diagnosis, implying a potential correlation between the trajectory of the disease and plasma glucose modulation.[23] Further studies have indicated that T1DM concomitant with DKA correlates with prolonged suboptimal plasma glucose regulation in pediatric patients.[24] Our own research identified a significant relationship between HbA1c concentrations and the presence of DKA. Additionally, the outcomes of our investigation revealed a discernible influence of the daily self-monitoring of blood glucose (SMBG) frequency on the regulation of plasma glucose levels. A plausible explanation is that frequent SMBG potentially serves as a reminder for patients to promptly regulate their plasma glucose through interventions such as dietary adjustments, physical activity, and appropriate insulin administration, subsequently optimizing HbA1c levels. In research focusing on pediatric patients diagnosed with T1DM, it was observed that an escalation in daily SMBG correlated with a notable decline in HbA1c levels and a decreased onset of acute sequelae like ketoacidosis.[25] CGM is an innovative tool proficient in perpetually monitoring

glucose concentrations in interstitial and subcutaneous tissues.[26] This device not only exhibits instantaneous plasma glucose readings and their respective trends but also incorporates alert systems, rendering it crucial for T1DM patient management. Empirical evidence suggests that CGM aids in fine-tuning plasma glucose regulation, aligning with previous scholarly findings.[27–30] Furthermore, the educational level of parents seems to have a consequential impact on the plasma glucose modulation in pediatric patients diagnosed with T1DM. Research conducted by AlAgha et al postulated that higher paternal educational level may be linked to enhanced plasma glucose regulation in children (reflected by HbA1c < 7%).[31] Conversely, a lower educational level could be associated with suboptimal regulation. Wu et al inferred that the educational status of the parents significantly influences the plasma glucose regulation of children.[32] Parents possessing advanced educational qualifications appear to exhibit heightened awareness regarding the implications of T1DM and the imperative nature of continuous glucose monitoring and management. In our findings, maternal education demonstrated a pronounced association with plasma glucose variations, whereas paternal education did not elicit a similar effect. This discrepancy may be attributed to the predominant role mothers tend to play in managing the treatment regimen of children diagnosed with T1DM.

Currently, the PedsQLTM instrument, developed by Varni et al at the Children's Hospital and Health Center in San Diego, California, is extensively used in China to assess the QOL of children and adolescents diagnosed with T1DM.[33] However, considering the pronounced disparities in dietary preferences, cultural backgrounds, lifestyles, and educational norms between Chinese and American children, there is a contention regarding the aptness of the PedsQLTM for the Chinese demographic. To cater to this specific context, and to more accurately gauge the QOL of pediatric patients diagnosed with T1DM, the "Questionnaire on Quality of Life of Children and Adolescents with Diabetes Mellitus in Chongqin", designed by Prof. Zheng Lingling, was employed in our investigation.[14]

Our findings highlighted several factors influencing the QOL of children with T1DM. These encompassed aspects such as plasma glucose control, dietary management, the occurrence of DKA, the cognitive abilities of the child, and the provision of health education. Among these, proficient regulation of plasma glucose emerged as pivotal for maintaining optimal QOL. Conversely, the incidence of DKA was identified as a risk factor negatively affecting T1DM QOL. Corroborating studies have showcased an association between superior plasma glucose regulation and enhanced QOL.[34] Evidently, children diagnosed with T1DM exhibiting inferior QOL typically manifested elevated HbA1c levels. Contrarily, those with reduced HbA1c levels not only demonstrated heightened QOL cognizance but also reduced vulnerability to acute complications, bolstering their overall QOL score.[35] Relative to their healthy peers, children and adolescents with T1DM exhibited an increased propensity toward psychosocial challenges such as depression and anxiety. These mental health parameters, in turn, could potentially impinge upon both plasma glucose regulation and QOL.[36] Our research ascertained diminished QOL in children diagnosed with T1DM with suboptimal plasma glucose regulation, juxtaposed against their better-regulated counterparts. Yet, it is paramount to note the nuanced relationship between reduced HbA1c levels and the holistic health perception, which typically corresponds to diminished disease impact, decreased anxiety, amplified satisfaction, and an augmented health cognizance. Moreover, daily routines, including dietary habits and glucose regulation, emerged as integral to QOL. Pervasive non-compliant diets and sedentary lifestyles predispose patients with T1DM to inferior plasma glucose regulation and resultant complications.[37] Unquestionably, comprehensive and continuous interventions are mandated for patients diagnosed with T1DM to forestall extended or latent complications.

A study conducted by Zhu underlined correlations between the QOL of pediatric patients diagnosed with T1DM and factors such as age, disease duration, educational attainment, familial income, the quality of the parent-child bond, and the marital status of the parents—findings that resonated with ours[38] Intriguingly, compared to an employed mother with advanced education, a lesser-educated mother might dedicate more time to overseeing the dietary and therapeutic needs of a T1DM child, ostensibly elevating the QOL of the children. Elevated parental expectations for academically proficient children could lead to more assiduous T1DM management. Socioeconomic factors, including parental unemployment, constrained income, and limited familial support, ostensibly undermine QOL. Compounded by poor glucose regulation and depressive symptoms, these socio-economic determinants exacerbate QOL degradation. Hence, while formulating T1DM management strategies, it is imperative to integrate socio-psychological considerations.

Limitation

The patient collection time is long, and the questionnaire is filled out jointly by the family members who take care of the child for a long time. Therefore, due to the cognitive differences between parents of different generations, there might be certain subjective biases.

Conclusion

The level of plasma glucose control in children and adolescents with T1DM in Ningxia is poor, and the QOL is lower. Several factors influence the control of plasma glucose in these patients, encompassing the duration of the disease, the age of the patients, the frequency of daily plasma glucose monitoring, the use of CGM, DKA, and the educational level of the mother. Various factors, such as plasma glucose control, dietary management, DKA, the ability to learn of the patients, and health education, are intrinsically linked to the QOL. To ameliorate both plasma glucose regulation and QOL, there is a need to fortify initiatives related to dietary management, meticulous monitoring of plasma glucose levels, and comprehensive health education.

Abbreviations

T1DM, Type 1 Diabetes Mellitus; QOL, Quality of Life; HbA1c, Glycosylated Hemoglobin; CGM, Continuous Glucose Monitoring; DKA, Diabetic Ketoacidosis; OGTT, Oral glucose tolerance test; CSII, Continuous Subcutaneous Insulin Infusion; MDI, Multiple Daily Injections; SMBG, Self-Monitoring of Blood Glucose.

Data Sharing Statement

We declared that materials described in the manuscript, including all relevant raw data, will be freely available to any scientist wishing to use them for non-commercial purposes, without breaching participant confidentiality.

Ethics Approval and Consent to Participate

This study was conducted with approval from the Medical research Ethics Review Committee of General Hospital of Ningxia Medical University (No. KYLL-2022-0242). This study was conducted in accordance with the declaration of Helsinki. Written informed consent was obtained from all participants.

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Disclosure

The authors declare that they have no competing interests.

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