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The transition challenge: quality of life, diabetes distress, and glycemic outcomes in emerging adults with type 1 diabetes

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Summary

Aim. Limited data exist on the relationship between diabetes distress (DD), quality of life, and metabolic control in Polish adolescents with type 1 diabetes mellitus (T1DM) during transition to adult care. This study examines associations among Polish 18-year-olds with T1DM as they transition from pediatric to adult diabetes care.

Methods. This cross-sectional study enrolled 110 consecutive patients aged 18 years with T1DM who completed the Problem Areas in Diabetes (PAID) questionnaire and Short Form Health Survey (SF-36v1). Continuous glucose monitoring (CGM) parameters were used to evaluate metabolic control.

Results. Diabetes distress (DD) correlated with all quality of life scales but not with glycemic control. Women reported higher diabetes-related distress ($p = 0.017$) and poorer mental health ($p = 0.009$) than men. Smokers demonstrated worse glycemic parameters ($p = 0.016$) and poorer mental health ($p = 0.008$). Unexpectedly, poorer glycemic control was associated with better quality of life. A longer disease duration and an earlier age at onset were associated with worse glycemic control.

Conclusions. Diabetes distress is more closely associated with quality of life than metabolic control in Polish 18-year-olds with T1DM. Females, individuals with longer disease duration, and smokers may benefit from targeted interventions emphasizing both psychological support and diabetes education.

Key words: diabetes mellitus type 1; Quality of Life; diabetes distress, transition of care

Introduction

Type 1 diabetes mellitus (T1DM) is one of the most common chronic diseases of childhood [1, 2]. Over 200,000 children develop the condition annually, with incidence rates continuing to rise [3]. In Poland, the incidence of T1DM among children increased tenfold over the past 40 years, reaching 32.43 per 100,000 in 2022 [4], with prevalence rising to 177 per 100,000 [4, 5]. Despite serious consequences of nonadherence to treatment, many patients experience difficulties in achieving adequate glycemic control [6]. Hyperglycemia can lead to serious long-term complications, while frequent hypoglycemic episodes may cause neuroglycopenic symptoms and, in severe cases, can lead to seizures, loss of consciousness, or even death. In patients using a continuous glucose monitoring (CGM) system, the CGM-derived metrics – including mean glucose (MG), coefficient of variation (CV), time in range (TIR, 70–180 mg/dL), time below range (TBR) levels 1 (55–70 mg/dL) and 2 (<55 mg/dL), and time above range (TAR) levels 1 (180–250 mg/dL) and 2 (>250 mg/dL) – should remain within recommended targets, namely TIR ≥70%, TBR level 1 <4% and level 2 <1%, TAR level 1 <25% and level 2 <5%, and CV ≤36% [7]. Polish population studies indicate that adolescents aged 17–20 are most vulnerable to deterioration in glycemic control [8], a phenomenon attributable to developmental stage–related factors [9] and the lack of effective transition mechanisms between pediatric and adult care. Studies on American populations indicate a similar phenomenon, with only about 20% of adolescents meeting recommended glycemic targets [10]. Diabetes poses significant burdens for adolescents and families. The disease requires self-management and adherence to demanding health regimens. Living with chronic illness may involve numerous physical, emotional, and social limitations that directly impact psychological functioning and quality of life [11–13]. Diabetes can negatively affect self-image through feelings of difference from peers or stigmatization experiences. Loss or restriction of autonomy due to treatment requirements or parental attitudes may strengthen rebellious tendencies and reluctance toward disease management [14]. Parental coping strategies and the overall emotional climate within the family play a crucial role in determining adolescents' quality of life and attitudes toward diabetes [15, 16]. Some parents tend to be overprotective or controlling [17], whereas others may adopt a permissive style and neglect health-related responsibilities [18].

Adolescence represents a critical developmental period for identity formation and the establishment of interpersonal relationships. Young people who experience a lower quality of life may reject the "sick role" and neglect self-management responsibilities. Although research findings do not consistently demonstrate significant differences in quality of life between youth with T1DM and their healthy peers, girls and individuals with poorer treatment adherence appear particularly vulnerable [19, 20]. Optimal psychological functioning plays a pivotal role in treatment engagement and favorable diabetes outcomes [21]. Quality of life is now recognized as a key therapeutic target, equally important as glycemic control [7, 22], and numerous studies have shown that these factors are closely interrelated [23–24]. Assessing quality of life may therefore serve as an important predictor of long-term treatment outcomes.

To date, no recent Polish studies have comprehensively examined the quality of life, diabetes distress, and their associations with metabolic control in young adults with T1DM. Updated data are essential for a better understanding of the health status of individuals entering adulthood and to inform the development of more effective, targeted interventions.

This study aims to assess the relationship between quality of life, diabetes distress, and metabolic control in young adults with T1DM participating in the transition from pediatric to adult diabetes care. Understanding these relationships may inform targeted interventions to support vulnerable individuals during this critical developmental period and improve both psychological well-being and clinical outcomes.

Material and method

The study included 110 consecutive individuals with T1DM attending their first visit at the adult diabetes outpatient clinic of Raszeja City Hospital in Poznan. The assessment was conducted as part of a pilot transition program. Inclusion criteria required fluency in Polish and the absence of cognitive impairment. Each initial visit involved the patient, a parent, a physician, a diabetes educator, and a psychologist. The visits included a comprehensive medical history and physical examination. Patients were informed about the clinic’s structure and procedures, and individualized treatment plans were established.

Participants completed standardized questionnaires collecting data on diabetes duration, previous hospitalizations, severe hypoglycemic episodes, diabetic ketoacidosis (DKA) events, comorbidities, complications, family history, alcohol consumption, smoking status, and physical activity. Body weight and height were measured to calculate body mass index (BMI). Data on diabetes management were retrieved from insulin pumps, glucometers, and continuous glucose monitoring (CGM) systems. Treatment data included daily insulin dose, basal-to-bolus ratio, and CGM-derived metrics: mean glucose (MG), coefficient of variation (CV), time in range (TIR, 70–180 mg/dL), time below range (TBR) levels 1 (55–70 mg/dL) and 2 (<55 mg/dL), and time above range (TAR) levels 1 (180–250 mg/dL) and 2 (>250 mg/dL). The explanations of the CGM metrics and their clinical significance are presented in Table 1. Patients completed the Short Form Health Survey (SF-36v1) to assess health-related quality of life and Problem Areas in Diabetes (PAID) to evaluate diabetes distress. The SF-36v1 is a 36-item questionnaire that measures quality of life across eight dimensions grouped into two domains: physical health (physical functioning, role limitations due to physical problems, bodily pain, and general health) and mental health (vitality, social functioning, role limitations due to emotional problems, and mental well-being). Higher scores indicate poorer quality of life, unlike the next version, where higher scores indicate higher quality of life. The PAID scale consists of 20 items rated on a 5-point Likert scale. The total score is obtained by summing all item scores and multiplying by 1.25 (maximum 100 points). Scores ≥40 suggest substantial emotional distress or diabetes burnout.

Table 1. **Characteristics of glycemic parameters of the study group**

Parameter name	Characteristics
TDD (Total Daily Dose of insulin)	Total amount of insulin administered per day, expressed in units (U).
Basal in TDD	Dose of basal insulin administered per day in units.
% basal	Percentage of basal insulin in the total daily insulin dose. Should typically be approximately 30-50% of TDD.
TDD/kg	Total daily insulin dose per kilogram of body weight. Allows comparison of doses between patients with different body weights. Typically 0.5-1.0 U/kg/day.
GMI (Glucose Management Indicator) [%]	Diabetes control indicator calculated based on mean glucose from CGM. Used in the study to estimate glycemic control over the past 12 weeks.
CV (Coefficient of Variation) [%]	Glucose variability coefficient. Indicator of glucose stability – the lower, the more stable the glucose levels. Treatment goal is to achieve <36%.
Mean glucose [mg/dL]	Arithmetic mean of all glucose measurements from CGM or glucometer during the analyzed period.
TAR >250 [%]	Percentage of time spent in very high hyperglycemia (>250 mg/dL). Treatment goal is to eliminate very high glucose levels to <5%.
TAR 180-250 [%]	Percentage of time in high hyperglycemia (180-250 mg/dL). Treatment goal is to achieve <25%.
TIR 70-180 [%]	Percentage of time in target range (70-180 mg/dL). Main therapeutic goal – should be >70%.
TBR 54-70 [%]	Percentage of time in hypoglycemia (54-70 mg/dL). Treatment goal is to limit to <4%.
TBR <54 [%]	Percentage of time in hypoglycemia (<54 mg/dL). Treatment goal is to minimize occurrence to <1%.

Due to deviations from normal distribution, nonparametric tests were applied. Medians and interquartile ranges (IQR) are presented. The Mann-Whitney *U* test was used for between-group comparisons, while Spearman’s rank correlation assessed variable relationships. Results were significant at $p < 0.05$.

Results

The study included 110 individuals with T1DM aged 18 years: 46 women (41.8%) and 64 men (58.2%). Median age at onset was 11.6 years (*IQR*: 8–16), and median disease duration was 13.7 years (*IQR*: 7–16) as presented in Table 2.

Table 2**. Characteristics of the study population (*n* = 110)**

Characteristic	***n* (%)**	**Median (IQR)**
Sociodemographic data		
Sex – F/M	46 (41.8) / 64 (58.2)	-
Age at onset (years)	-	11.6 (8.00–16.0)
Disease duration (years)	-	13.7 (7.00–16.0)
BMI (kg/m²)	-	22.9 (20.9–25.9)
Hours of sleep per day	-	7.50 (7.00–8.00)
Months since last diabetologist visit	-	3.00 (2.00–5.00)
Substances and physical activity		
Smoking – No/Yes	91 (85.0) / 16 (15.0)	-
Alcohol consumption – No/Yes	64 (60.4) / 42 (39.6)	-
Frequency of alcohol consumption (times/month)	-	1.50 (0.60–2.00)
Physical exercise – No/Yes	53 (49.5) / 54 (50.5)	-
Insulin therapy and technologies		
Insulin delivery method – Pump/Pens	87 (79.8) / 22 (20.2)	-
Closed loop – No/Yes	96 (87.3) / 14 (12.7)	-
Sensor – Yes/No	104 (94.5) / 6 (5.5)	-
Total daily insulin dose (U)	-	49.1 (34.4–60.6)
Basal in TDD (%)	-	41.0 (31.8–50.0)
Total daily insulin dose (U/kg)	-	0.72 (0.52–0.88)
Comorbidities and complications		
Chronic medication use other than insulin – No/Yes	79 (75.2) / 26 (24.8)	-
Other chronic diseases – No/Yes	74 (69.2) / 33 (30.8)	-
Family history of diabetes – No/Yes/Don't know	80 (75.5) / 25 (23.6) / 1 (0.9)	-
Severe hypoglycemia – No/Yes	98 (91.6) / 9 (8.4)	-
Diabetic ketoacidosis – No/Yes	89 (83.2) / 18 (16.8)	-
Glycemic control parameters for n = 106		
GMI (%)	-	7.10 (6.70–7.75)
CV (%)	-	39.1 (33.2–44.1)
Mean glucose (mg/dL)	-	159 (142–182)
TAR >250 (%)	-	8.00 (3.00–18.0)
TAR 180–250 (%)	-	21.0 (16.2–26.0)

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TIR 70–180 (%)	-	62.0 (49.0–75.8)
TBR 54–70 (%)	-	3.00 (1.00–5.00)
TBR <54 (%)	-	0.00 (0.00–1.00)

Values presented as *n* (%) for categorical variables and median (IQR) for continuous variables. BMI – Body Mass Index; CGM – Continuous Glucose Monitoring; CV– Coefficient of Variation; F – Female; GMI – Glucose Management Indicator; M – Male; TAR – Time Above Range; TBR – Time Below Range; TDD – Total Daily Dose; TIR – Time in Range.

The distributions of all variables deviated from normality (Shapiro-Wilk test, $p < 0.05$). Reliability analysis revealed that several SF-36 scales required exclusion due to reliability below $\alpha = 0.60$. Median SF-36 Physical Health, Mental Health, and Overall Quality of Life Index scores were 19.1 (6.4–61.0), 21.1 (5.5–93.3), and 20.5 (6.4–68), respectively. PAID demonstrated excellent reliability ($\alpha = 0.94$) with a median of 14.4 (5.31–27.5). The data are presented in Table 3.

Table 3**. Statistical characteristics and reliability of SF-36 and PAID questionnaire scales (*n* = 110)**

Scale/Subscale	M	SD	Mdn	Min-Max	IQR	Cronbach's α
SF-36: Physical functioning	5.42	11.5	0.00	0–90	0.00–6.00	0.85
SF-36: Role limitations – physical problems	13.0	21.9	0.00	0–100	0.00–25.0	0.58
SF-36: Bodily pain	22.0	18.4	22.2	0.00–77.8	11.1–33.3	0.038
SF-36: General health	46.3	14.6	45.8	16.7–95.8	34.3–54.2	0.59
SF-36: Vitality	42.4	16.2	42.5	10–85	30.0–50.0	0.46
SF-36: Social functioning	20.7	24.6	12.5	0–100	0.00–34.4	0.71
SF-36: Role limitations – emotional problems	14.2	27.3	0.00	0–100	0.00–33.3	0.69
SF-36: Mental well-being	33.3	18.0	32.0	4.50–92	21.0–40.0	0.75
SF-36: Physical health	21.7	10.7	19.1	6.40–61.0	13.5–27.5	0.53
SF-36: Mental health	27.7	18.0	21.1	4.50–93.3	15.3–34.6	0.82
SF-36: Quality of life index	24.7	12.9	20.5	6.40–68.0	15.8–29.5	0.62
PAID	18.7	17.3	14.4	0.00–86.3	5.31–27.5	0.94

M – Mean; SD – Standard Deviation; Mdn – Median; IQR – Interquartile Range; PAID – Problem Areas in Diabetes; SF-36 – Short Form Health Survey. Shapiro-Wilk test was used to assess normality of distribution. Cronbach's α indicates internal consistency reliability.

As Table 4 presents, women reported significantly poorer SF-36 Mental Health scores compared with men [20.0 (15.0–29.0) vs. 15.0 (12.0–20.0); $p = 0.009$] and higher PAID scores [17.5 (10.0–40.3) vs. 11.9 (3.8–20.0); $p = 0.017$]. No significant sex differences were found in glycemic control ($p > 0.05$). Smokers demonstrated poorer glycemic parameters compared with non-smokers: GMI [7.8 (7.25–8.10) vs. 6.9

(6.6–7.6)%; $p = 0.016$] and mean glucose [189 (160–205) vs. 154 (141–179) mg/dL; $p = 0.014$]. Smokers also had poorer SF-36 Mental Health scores [26.0 (18.5–41.3) vs. 16.0 (13.0–22.0); $p = 0.008$]. Physical functioning showed moderate associations with glycemic control, displaying a positive correlation with time in range (TIR; $r = 0.25$, $p < 0.001$) and negative correlations with mean glucose ($r = -0.22$, $p < 0.01$), time above range (TAR) 180–250 mg/dL ($r = -0.22$, $p < 0.01$), and TAR >250 mg/dL ($r = -0.26$, $p < 0.001$). The PAID total score correlated positively with all SF-36 dimensions of quality of life, including physical functioning ($r = 0.21$, $p < 0.01$), social functioning ($r = 0.24$, $p < 0.01$), role limitations due to emotional problems ($r = 0.25$, $p < 0.01$), mental well-being ($r = 0.26$, $p < 0.001$), mental health ($r = 0.32$, $p < 0.001$), and the overall Quality of Life Index ($r = 0.36$, $p < 0.001$).

Disease duration correlated positively with poorer glycemic control, as reflected by higher mean glucose ($r = 0.413$, $p < 0.001$), TAR >250 mg/dL ($r = 0.436$, $p < 0.001$), and TAR 180–250 mg/dL ($r = 0.244$, $p < 0.05$), and negatively with TIR ($r = -0.471$, $p < 0.001$). Later age at diabetes onset correlated negatively with mean glucose ($r = -0.333$, $p < 0.001$), TAR >250 mg/dL ($r = -0.308$, $p < 0.01$), TAR 180–250 mg/dL ($r = -0.257$, $p < 0.01$), and positively with TIR ($r = 0.358$, $p < 0.001$).

Table 4. **Between-group comparisons**

Variable	Women ($n = 46$)	Men ($n = 64$)	p	Non-smokers ($n = 91$)	Smokers ($n = 16$)	p
GMI (%)	6.90 (6.70–7.90)	7.10 (6.62–7.60)	0.962	6.90 (6.60–7.60)	7.80 (7.25–8.10)	0.016
Mean glucose (mg/dL)	155 (142–188)	160 (142–180)	0.990	154 (141–179)	189 (160–205)	0.014
SF-36: Mental health	20.0 (15.0–29.0)	15.0 (12.0–20.0)	0.009	16.0 (13.0–22.0)	26.0 (18.5–41.3)	0.008
SF-36: Quality of life index	52.5 (40.3–65.5)	45.0 (36.0–55.3)	0.080	46.0 (36.0–57.0)	61.0 (42.3–72.0)	0.059
PAID score	17.5 (10.0–40.3)	11.9 (3.75–20.0)	0.017	12.5 (5.63–26.3)	17.5 (7.50–28.8)	0.606

Values presented as median (IQR). The Mann-Whitney U test was used for group comparisons. Bold values indicate statistical significance ($p < 0.05$). GMI – Glucose Management Indicator; PAID – Problem Areas in Diabetes; SF-36 – Short Form Health Survey.

Discussion

The study revealed several significant relationships among the analyzed variables in Polish 18-year-olds with type 1 diabetes mellitus (T1DM). Levels of diabetes distress and quality of life differed from those reported in broader T1DM cohorts. Schmitt et al. [25] found nearly twice as high a mean diabetes distress in participants with double the mean age. SF-36 results in the present study indicated markedly lower scores compared with age-heterogeneous samples [26], suggesting that quality of life and diabetes distress likely vary across age groups. Younger patients are more likely to use advanced diabetes technologies, which may contribute to higher perceived quality of life. Parental support and structured healthcare provision through scheduled clinical encounters, particularly those tailored to the transition period, may also play a protective role.

Female participants were more vulnerable to diabetes-related distress and reported poorer mental health than males, consistent with previous findings [27–29]. Women may be encouraged toward greater independence earlier, leading to the perception of diabetes management as more burdensome. Additionally, body-related stigmatization may culturally affect women more strongly. Concerns about insulin-related weight gain and heightened sensitivity to peer comparison can exacerbate stress and reduce quality of life in women.

Between-group analyses demonstrated poorer mental functioning and glycemic control among smokers, in line with prior research [30, 31]. Scales et al. [32] reported that adolescents often perceive smoking as an effective coping strategy for stress. Such individuals may require enhanced psychological support aimed at reducing tobacco use as a form of emotional regulation.

Interestingly, an unexpected inverse relationship between quality of life and glycemic control was observed – poorer glycemic outcomes were associated with higher reported quality of life. This finding contradicts previous studies that found the opposite pattern, where poorer glycemic control was associated with lower quality of life [33], or studies that found no association at all [34]. Adolescents investing more effort in diabetes management may be more aware of disease-related limitations, whereas those with poorer control may perceive diabetes as having less impact on their lives. The desire to “live normally” may lead to reduced focus on glycemic control but greater life satisfaction. Another possible explanation is that more controlling parental behavior could facilitate better glycemic results at the expense of adolescents’ perceived quality of life. Future studies should therefore incorporate family context. Higher quality of life among poorly controlled individuals may also relate to disease duration – longer disease experience may foster adaptation, whereby patients accustomed to treatment routines perceive them as less burdensome despite suboptimal metabolic outcomes.

Diabetes distress correlated positively with all quality of life dimensions. Although no association with glycemic control was observed, this suggests that subjectively experienced psychological difficulties in managing diabetes are stronger predictors of quality of life than metabolic indicators.

Longer disease duration and earlier age at onset were associated with poorer glycemic control, consistent with findings described by Hilliard et al. [35]. However, other studies suggest that individuals with adolescent-onset are particularly vulnerable [36]. These patients may struggle with transferring diabetes management responsibilities from their parents to themselves. However, this result might be related to the remission time, lower demand for insulin, and better glycemic control in people with short diabetes duration.

Conclusions

Diabetes distress appears more closely associated with quality of life than with metabolic control in Polish 18-year-olds with T1DM. Female participants were more vulnerable to distress and poorer mental health. Paradoxically, poorer glycemic control was associated with higher quality of life. These findings underscore the importance of dual-track interventions that combine individualized psychological care with diabetes education. Particular attention should be directed toward women, individuals with longer disease duration, and those with suboptimal glycemic control.

Future longitudinal studies should examine whether targeted psychosocial interventions during the transition to adult care can improve both emotional well-being and metabolic outcomes. In addition, a qualitative analysis of PAID responses could be conducted to identify which specific areas of functioning represent the greatest sources of stress for individuals living with diabetes.

Limitations

Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference. Second, several SF-36 subscales were excluded due to insufficient internal consistency ($\alpha < 0.60$). Third, contextual factors such as family functioning and socioeconomic status were not assessed. Finally, some participants may have been in the diabetes “honeymoon” phase, potentially affecting metabolic results.

Ethical considerations

The authors declare no conflicts of interest and report no external funding. The study was conducted in accordance with the Declaration of Helsinki and approved by the Bioethics Committee of the Karol Marcinkowski University of Medical Sciences in Poznan. Written informed consent was obtained from all participants prior to inclusion in the study.

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