DOI: 10.4274/jcrpe.galenos.2025.2025-1-21

Research Article

Type 1 Diabetes Mellitus and Transfer from Pediatric to Adult Care: A Single-Center Experience

Yiğit Yalçın B et al. Pediatric to Adult Care in T1D

Betül Yiğit Yalçın[1], Ummahan Tercan[2], Melek Yildiz[2], Hülya Hacısahinogulları[1], Gülşah Yenidünya Yalın[1], Nurdan Gül[1], Ozlem Soyluk Selcukbiricik[1], Ayşe Kubat Üzüm[1], Sukran Poyrazoglu[2], Firdevs Baş[2], Kubilay Karşıdağ[1], İlhan Satman[1], Feyza Darendeliler[2]
[1]İstanbul University, İstanbul Faculty of Medicine, Department of Endocrinology, İstanbul, Türkiye
[2]İstanbul University, İstanbul Faculty of Medicine, Department of Paediatrics, Division of Paediatrics Endocrinology, İstanbul, Türkiye

What is already known on this topic?
• Transitioning from pediatric to adult care is a challenging period for patients with T1D, often resulting in poor glycemic control and increased dropout rates.
• Effective transition models are essential for ensuring continuity of care and reducing complications.
What this study adds?
• This study shows that regardless of the transition model, patients experienced improvements in HbA1c levels and insulin management during adult care follow-up. These findings emphasize the importance of supporting adolescents with T1D during the transition period with coordinated care models tailored to their needs.

Abstract
Introduction: Type 1 diabetes mellitus (T1D) necessitates lifelong management, and a standardized transition protocol with multidisciplinary support can help ease the shift from pediatric-focused healthcare to adult care systems.
Aim: Our objective was to assess the sociodemographic data, clinical features, and laboratory parameters that may influence the transition period and post-transition process among patients with T1DM and to compare results between two different transition models.
Methods: We retrospectively analyzed 64 T1D patients who transitioned to the adult outpatient clinic at Istanbul University, Istanbul Faculty of Medicine. Patients were followed up between 2001 and 2022, completed their pediatric follow-up, and participated in the shift from pediatric to adult outpatient care. Demographic data, clinical and metabolic parameters before and after the transition, the presence of diabetic complications and comorbidities, and treatment modalities were analyzed. These patients were transferred to adult care with two different transition models: in model 1, the transition was performed in a single meeting, whereas in model 2, it was performed over a period of 4–6 months. Due to pandemic-related disruptions, a few patients were transferred following telephone consultations and were excluded from model comparisons. The differences between the outcomes of the transition models were also examined.
Results: Sixty-four patients were included in the analysis (43.7% female, age at diagnosis 9.4±3.9 years). At their last pediatric visit, the participants had a mean age of 19.4 ± 1.2 years (range 16.6–21.9). The mean age at transfer to adult care was 20.2 ± 1.4 years (17.7–23.1), and the mean age at the most recent adult visit was 23.2 ± 4.2 years (18.4–39.5). The median time in adult care follow-up was 3.3 (range 0.3-20.9) years. The mean body mass index (BMI) decreased from 24.1 ± 4.7 kg/m² at transition to 23.6 ± 3.5 kg/m² during adult follow-up. Although the mean BMI fell slightly, obesity prevalence rose from 1.6 % to 9.6 %, reflecting a right-shift in the BMI distribution. Annual routine diabetes-care visits decreased from 3.0 ± 0.9 visits per year during pediatric follow-up to 2.1 ± 1.8 visits per year in adult care (p=0.009). The mean HbA1c level was significantly lower in adults (8.9% vs. 8.3%; p=0.007). Total insulin doses were significantly higher at transition than at the last adult care visit (0.95 vs 0.75 IU/kg/day; p=0.009). Basal insulin ratio was higher in adulthood (43.1% vs. 52.8%; p<0.0001). The use of continuous subcutaneous insulin infusion (CSII) therapy in adult care was higher (4.7% vs. 12.5%, p=0.11). The frequency of autoimmune thyroiditis and coeliac disease did not differ between adult and pediatric care. Although the frequency of microvascular and macrovascular complications increased in adult care, there was no statistically significant variation in acute and chronic complications. There were no statistically significant differences in glycemic outcomes, insulin requirements, or complication rates between transition models 1 and 2.
Conclusion: We conclude that a structured transition process may support better glycemic control and improved treatment adaptation in T1D management regardless of the model whether it involves a single-session or a gradual model, HbA1c levels improved during adult care, along with reduced insulin doses and increased basal insulin ratios. However, no significant difference was found between the two structured transition models, emphasizing the need for individualized and supportive approaches during this process.
Keywords: Type 1 diabetes mellitus, transfer to adult care, metabolic change, transition models

Betül Yiğit Yalçın, MD,
İstanbul University, İstanbul Faculty of Medicine, Department of Endocrinology, İstanbul, Türkiye
byigit667@gmail.com
0000-0002-5533-330X

03.02.2025
03.09.2025

Epub: 17.09.2025

Introduction

Type 1 diabetes mellitus (T1D) is a chronic disease that usually occurs in childhood and adolescence, and requires lifelong follow-up and treatment. The transition process refers to the transition of an individual with diabetes from pediatric care to adult care, and this process is a fragile and sensitive period for individuals. Significant changes take place in their school lives, working and financial situations during this process. They struggle with the psychological and physiological conditions of adolescence (1). It is also a period in which they gradually take responsibility for their illness from their families. These changes in patients' personal lives and medical care may disrupt diabetes follow-up and treatment. (2–4). A poorly planned transition leads to 60% of these patients dropping out of follow-up (5). Studies have shown that glycemic control worsens during the transition from childhood to adulthood (6). The period when HbA1c levels are the highest is the transition period of patients, that is, late adolescence and early adulthood. Poor glycemic control is associated with an increased risk of chronic complications and mortality (7, 8). Approximately 50% of young adults with T1D develop diabetes-related complications such as retinopathy, neuropathy and hypertension in their 20s (9). Shifting from pediatric to adult follow-up is crucial for enhancing patient

compliance and, consequently, improving long-term patient monitoring and health outcomes. The transition from pediatric to adult follow-up should be seamless and well coordinated, considering the social and psychological development of the patient (10). The American Diabetes Association recommends that preparations for adult follow-up begin one year before transition and that patients should be encouraged and educated about their diabetes responsibilities during adolescence. (11).

To strengthen the support provided to young adults with T1D, it is essential to determine both risk factors and protective mechanisms. In our study, we aimed to retrospectively analyze the sociodemographic, medical, and laboratory features of individuals with type 1 diabetes who transitioned from pediatric to adult care at our hospital, and to compare the outcomes of two different structured transition models. We hypothesized that structured and gradual transition models would be associated with better metabolic outcomes and treatment adherence compared to single-session transfers.

Material and Method

Research Design

This study was conducted as a retrospective cohort analysis to examine the sociodemographic, clinical, and laboratory characteristics of patients with T1D who transitioned from pediatric follow-up to the adult endocrinology outpatient clinic at Istanbul University, Istanbul Faculty of Medicine, and to compare different transition models. A total of 73 T1D patients who completed pediatric care and were transferred to adult follow-up between 2001 and 2022, and whose medical records were accessible, were initially considered for inclusion. However, 5 patients who were lost to follow-up after a single visit and 4 patients who had only recently been transferred were excluded from the final analysis. As a result, complete pediatric and adult electronic medical records of 64 patients were included in the study. Exclusion criteria were: missing data, discontinuation of care before transfer to adult follow-up, and a diagnosis of type 2 diabetes mellitus. Due to the retrospective nature of the study and the wide time frame (2001–2022), the duration of adult follow-up varied significantly. While some patients had only recently transitioned, others had been under adult care for more than a decade. This variability resulted in a broad follow-up range, from a few months to over 20 years. Sociodemographic characteristics, clinical data, and laboratory findings were obtained retrospectively from patient files. A detailed flowchart illustrating the sample selection process is provided in Figure 1.

Transition Models

In Model 1 (n=36), the transition was conducted through a single structured meeting lasting 90 minutes in the pediatric endocrinology clinic, where the clinical evaluation was carried out by the pediatric endocrinology team**.** This session was attended by pediatric endocrinologists, adult endocrinology and metabolism specialists, pediatric and adult diabetes nurses and diabetes dietitians along with the patient and their family. During the meeting, patients received comprehensive education covering: (a) detailed explanation of adult clinic expectations and procedures including appointment scheduling and emergency protocols, (b) assessment of current clinical status and self-care competencies, and (c) personalized transition goal setting.

In Model 2 (n=24), the transition process involved two structured meetings (60–90 minutes each) conducted over a 4–6 month period by a multidisciplinary team comprising pediatric and adult endocrinologists and dietitians. The first meeting was held in the pediatric endocrinology clinic, while the second took place in the adult endocrinology outpatient clinic. The number of visits was increased in individuals with low cooperation. Specifically, for two patients who were considered not yet ready to assume full responsibility for diabetes self-management, the number of structured visits was increased to three. These additional sessions aimed to enhance self-care competency and support a smoother transition into adult services. These sessions were designed to: (a) provide graduated education on autonomous disease management, (b) reinforce self-monitoring skills and complication prevention strategies, and (c) administer final competency evaluations before adult care transfer. Both meetings incorporated individualized care planning based on continuous glucose monitoring data and HbA1c trends.

All transition meetings systematically addressed three core domains: (1) clinical status evaluation (including glycemic control metrics and complication screening), (2) self-management capacity building (emphasizing medication adherence and problem-solving skills), and (3) healthcare system navigation training (covering insurance transition and adult service utilization).

During the COVID-19 pandemic period, 4 patients were transferred directly to the adult endocrinology outpatient clinic as face-to-face transition meetings could not be held. Instead, these patients received information regarding the transition process via telephone consultation. Since their transfer procedures did not align with the structured models and could introduce bias in group-based statistical comparisons, they were excluded from the model analyses.

Methods

Sociodemographic data included sex, age, body mass index (BMI) and diabetes education status of the patients. The duration of the disease, number of medical appointments during the transition period, average number of annual visits in pediatric and adult follow-up, insulin treatment dose, use of continuous subcutaneous insulin infusion (CSII) therapy, diabetes-related acute (number of emergency admissions with diabetic ketoacidosis) and chronic complications (retinopathy, neuropathy, hypertension), comorbidities, and HbA1c levels were also evaluated. Data on the screening, diagnosis, and treatment of microalbuminuria, neuropathy, retinopathy and dyslipidemia were collected for each patient prior to and after the transition. HbA1c levels were evaluated based on the mean values recorded during pediatric and adult follow-up visits. For hyperlipidemia, LDL ≥100 mg/dL and statin use were recorded as dyslipidemia. Patients with a urine microalbumin/creatinine ratio of ≥ 30 mg/g were considered to have microalbuminuria. The pre- and post-transition examination records were evaluated for retinopathy and peripheral neuropathy.

Data Analysis Statistical Analysis

The data obtained in the study were analyzed using SPSS software version 23. Descriptive statistics (mean, standard deviation and frequency) and comparative analysis methods (t-test and chi-square test) were utilized to assess variations among the groups. For statistical significance, a threshold of $p < 0.05$ was applied.

Ethical Approval

The study was approved by the Ethics Committee of Istanbul University, Istanbul Faculty of Medicine with the reference number [2023/785].

Results

Population characteristics

In this study, a retrospective analysis was conducted on the medical records of 64 patients with T1D who transitioned from pediatric follow-up to the adult endocrinology outpatient clinic at Istanbul University, Istanbul Medical Faculty. Among the patients enrolled in the study, 43.7% were female, and the average age at diagnosis was 9.4±3.9 years (range 0.8-17.5 years). At their last pediatric visit, the mean age of the patients was 19.4 ± 1.2 years (range: 16.6–21.9). The mean age at the time of transition to adult care was 20.2 ± 1.4 years (range: 17.7–23.1), and the mean age at the last adult visit was 23.2 ± 4.2 years (range: 18.4–39.5). The median follow-up duration after transition to adult care was 3.3 years (range 0.3–20.9); among the 64 patients, 32.8 % were seen within the first 6 months, 51.6 % within the first 2 years, and 75 % within 4 years. Body mass index (BMI) decreased from 24.1 ± 1.7 kg/m² at transition to 23.6 ± 3.5 kg/m² at the last adult visit. While the prevalence of obesity was 1.6% in the pediatric follow-up, this rate increased to 9.6% at the last visit in adult care. Although mean BMI showed a small reduction, the standard deviation widened and the proportion of participants in the obese category rose from 1.6 % to 9.3 %. This indicates a right-shift in the BMI distribution—with more individuals crossing the obesity threshold—despite a marginal fall in the group mean (Table 1).

Clinical outcomes

Routine control visits in diabetes care were more frequent during pediatric follow-up (3.0 ± 0.9 vs. 2.1 ± 1.8, **p=0.009**). Total insulin doses at the time of transition were significantly higher compared to the last visit in adult care (0.95 IU/kg/day at transition vs. 0.75 IU/kg/day in adult care; **p=0.009**). The proportion of basal insulin was higher in the adult care group (43.1% in pediatric follow-up, 52.8% in adult care; **p < 0.0001**). Although CSII was used more frequently in the adult care group (12.5% vs. 4.7%), this variation was not statistically significant (p=0.11). The mean HbA1c levels were significantly lower in the adult period (8.9% in pediatric follow-up vs. 8.3% in adult care; **p=0.007**). (Table 2).

To minimise the potential bias introduced by very long adult follow-up times, we re-analysed outcomes in the subgroup with ≤ 4 years of adult follow-up (n = 48). The direction and magnitude of the main findings remained unchanged: HbA1c decreased from 8.85 ± 1.63 % to 8.36 ± 1.86 % (**p=0.047**), daily insulin requirement declined (0.87 ± 0.27 vs 0.80 ± 0.27 IU/kg; **p < 0.001**), and the basal-insulin ratio increased (44.2 ± 12.4 % vs 51.2 ± 11.6 %; **p < 0.001**). Visit frequency was still lower in adulthood (2.9 ± 0.7 vs 2.3 ± 0.7 visits/year; **p=0.039**). Detailed results are provided in Supplementary Table S1.

Complications and comorbidities

There was no difference in the frequency of autoimmune thyroiditis and celiac disease between pediatric and adult care. During adult care, the rate of microvascular and macrovascular complications rose; however, no significant statistical variation was observed in acute and chronic complications (Table 3).

No significant differences were observed between the two groups in mean HbA1c, annual visit frequency, BMI, insulin dose, carbohydrate-counting knowledge or practice, CSII/MDI/CGM use, or the prevalence of nephropathy and neuropathy (Supplementary Table S2). The same overall pattern was confirmed in a sensitivity analysis restricted to participants with ≤ 4 years of adult follow-up (Supplementary Table S3); the only between-model differences were a slightly higher pediatric visit frequency and a larger reduction in visit rate after transfer in Model 1 (**p=0.025** and **p=0.014**, respectively).

Discussion

The transition from pediatric to adult care is a difficult process in many respects, and patients with diabetes are currently prepared for the transition period from pediatric to adult care in limited centers (12). For patients to undergo a smooth transition, the distinctions between pediatric and adult care should be appropriately addressed. In this study, patients with T1D who switched from pediatric to adult follow-up were examined using pre- and post-transition data, and two different transition models were compared. Our findings show that the mean age at the time of transition to adult care was 20.2 ± 1.4 years (range 17.7–23.1). Early transition age may be advantageous for individual adaptation; however, many authors suggest that transition occur after psychosocial maturity (13). Therefore, transition age should be determined by considering the patient's social and clinical status, and pediatric endocrinologists should make individualized decisions based on these factors.

In our study, a comparison of patients' mean HbA1c levels before and after transfer demonstrated a notable reduction in HbA1c levels during the adult period (8.3 %±1.6% vs 8.95%± 1.6%, **p=0.007**). Young people made up the largest proportion among groups with poor diabetes management (HbA1c ≥9.5%), and high HbA1c levels were detected in 25% of patients older than 12 years (14, 15). In a review, HbA1c improved significantly after transition to adult care in five of the eight studies examined. Although care centers and transition methods differed in these studies, it was thought that the transition facilitated adult care (16). In adult care, individuals assuming greater responsibility for disease management and engaging more in follow-up and treatment may contribute to the decrease in HbA1c levels (15, 17). However, in a retrospective study by Walch et al. (18), no notable alteration in HbA1c levels was detected after the transition to adult care. Another study examined standard and intervention transition methods, enrolling 101 patients under routine care and 102 individuals in the intervention-based transition group. Although HbA1c levels were similar 12 and 18 months after transition, participation in health services was higher in the intervention transition group (19). Our findings are in line with the systematic review by DeLacey et al., which highlighted that while structured transition programs or provider-led interventions may yield modest improvements in glycemic control after transfer, the overall evidence base remains limited and inconsistent. Most existing studies lack long-term follow-up or standardized outcome reporting, making it difficult to draw strong conclusions regarding the effectiveness of transition strategies (20).

Differences in insulin treatment were observed in adult care compared to those before transition. During the adult care period, the total daily insulin dose was noticeably lower than the dose at the time of transition (0.75 IU/kg/day vs 0.95 IU/kg/day **p=0.009**). This decrease in insulin dose after transition to adult care is consistent with the end of puberty and resolution of physiologic and psychological problems such as insulin resistance related to puberty (1, 21, 22). A structured transition process can support improved glycemic control in T1D management, whether implemented through single-session or stepped models. Our protocolized transition approach (featuring standardized training modules, multidisciplinary team involvement, and competency assessments as detailed in Methods) was associated with clinically meaningful HbA1c reduction and decreased insulin requirements, suggesting effective care continuity during the transfer to adult services. In our study, we found an increased basal insulin ratio in the adult group (52.8 ± 11.3 vs. 43.1 ± 10.8, **p < 0.0001**) and this finding is consistent with the literature, which reports that basal insulin requirements in children usually do not exceed 30-45% of the total daily insulin dose, whereas this ratio usually exceeds 50% in adults. This is noteworthy in view of the fundamental changes in the insulin regimen during the transition to adulthood (23-26). This increase in basal insulin rate may be due to the need for more frequent insulin dose adjustments at meals and higher bolus insulin requirements during childhood (25, 27, 28). Positive effects of CSII on glycemic control have been reported in the literature (29). We found that the rate of CSII use in adult care was relatively higher than in pediatric care, suggesting that access to emerging technologies and individualized treatment options in diabetes care may be more prevalent in adult patients. Additionally, time passing while patients were growing up may have made technology more accessible. Our finding was not significant statistically but this result should be re-evaluated with a larger sample groups**.** Furthermore, although follow-up durations varied widely in our cohort, a sensitivity analysis limited to patients with ≤ 4 years of adult follow-up did not alter the main findings for HbA1c, insulin requirements, or the other key outcomes. Nevertheless, it remains possible that very long follow-up periods could partially obscure the true impact of the transition process. Studies on the effect of transition on the frequency of follow-up in T1D patients have yielded variable results (30, 31). In a study comparing interventional transition with standard transition, 104 patients were included in the transition program, while 101 patients underwent a standard transition plan. Follow-up frequency and patient satisfaction were found to be higher in the intervention transition group. However, these benefits were not sustained in the 12-month period after the completion of the intervention and it was emphasized that strategies are needed to sustain long-term benefits (3). In an Australian study involving 60 participants in the intervention group and 60 in the control group, no difference was found in the average frequency of appointments between the two groups over 12 months. Although the number of visits decreased in the adult follow-up, HbA1c was found to be lower in the present study (30). Our findings are consistent with the study by Busse et al., who observed a decrease in outpatient visits during adulthood and interpreted this as adults taking responsibility for their own care (31).

Diabetes-related complications before and after transition have been investigated less frequently. Walch et al. retrospectively analyzed the medical records of 54 T1D patients. Hypertension, dyslipidemia, nephropathy, and neuropathy among complications were examined in patients who switched from pediatric care to adult follow-up, and no significant difference was found in the rate of complications before and after transition (18). A study conducted in Canada showed that the frequency of retinopathy screening did not change before and after transition, while at the same time, there was no significant difference in the rate of hospitalization due to diabetes before and after transition (32). Although micro- and macrovascular complications were observed more frequently in adult care in our study, the difference between

acute and chronic complications in the pre-transition period was not statistically significant. This finding may be due to the longer pediatric follow-up period (10.6±4.1 years) compared to the adult follow-up period (3.1±4.2 years). The shorter follow-up period in adult care suggests that some complications may not have yet fully emerged in these patients, or that complications may not have been recognized early. Future research with an extended monitoring period is required to validate these results. Furthermore, given the wide range in adult follow-up durations (from less than one year to over 20 years), complication-related outcomes should be interpreted with caution. In patients with shorter follow-up durations, chronic complications may not have had sufficient time to manifest or be detected.

Some studies have shown that single-session transitions can increase patient satisfaction and engagement. In one study, a single-session transition clinic model positively affected patient and parent satisfaction and made the transition process more effective. However, for some patients, this rapid transition can be stressful. In contrast, gradual transitions have been shown to facilitate patient compliance and increase treatment adherence, but it has also been emphasized that such gradual transitions require more resources (33). For the gradual transition model, it has been reported in the literature that this method can facilitate the adaptation process of young people. A study by the American Diabetes Association found that young people prefer a delayed or gradual transition to adult care. In this reserch, young people expressed that they found it more comfortable to transition to adult care with a longer transition period, especially due to their commitment to pediatric care providers (34, 35). However, in our study there was no difference with respect to transition models. In the ≤ 4-year sensitivity comparison, we found no clinically meaningful differences between the two structured transition models in metabolic control or complication rates; the only divergence was a slightly higher pediatric visit frequency and a more pronounced decline in visit rate after transfer in Model 1, a pattern that did not translate into any adverse clinical outcomes.

Limitations

To be conducted at a single institution with a restricted patient cohort (64 patients) is a limitation of our study. This may limit the applicability of the findings to larger or more diverse populations. Moreover, because structured transition care has been mandatory for all young people with T1D at our centre since 2000, it was impossible to assemble a control group that underwent an unstructured transfer; the absence of such a comparator limits our ability to quantify the added value of the transition models. Additionally, our study did not include assessments of psychosocial readiness, patient satisfaction, or family involvement, which are increasingly recognized as critical components of successful transition. This limits our ability to capture the broader patient experience and evaluate non-medical outcomes related to the transition process. Finally, adult BMI is reported as mean ± SD together with weight-status categories because a validated adult BMI-SDS reference is not available and paediatric SDS could not be calculated uniformly for all participants; this may hinder direct comparison with studies that report z-scores.

Conclusion

Considering the difficulties and varying outcomes of transitioning from pediatric to adult care, developing individualized approaches can significantly improve patient experiences and long-term diabetes management. However, transition outpatient clinics present several challenges in daily practice, including resource limitations, multidisciplinary work, compliance and additional time for both healthcare professionals and patients. Therefore, further research is required to evaluate the long-term impact of transition outpatient clinics and to assess the effectiveness of different models in managing blood glucose levels, preventing complications, and enhancing patient experience, ultimately improving the transition process.

Grants or Fellowships: This study was not supported by any external grants or fellowships.
Ethical Approval: Ethical approval for this study was obtained from the Ethics Committee of Istanbul University, Istanbul Faculty of Medicine (Approval Number: 2023/785).
Acknowledgments: We thank the Istanbul University Pediatric Endocrinology Clinic for their support in patient data collection.
Prior Presentation: This study was presented as a poster at the European Congress of Endocrinology (ECE) 2023, held in Istanbul, Turkey.

References

1. Amiel SA, Sherwin RS, Simonson DC, Lauritano AA, Tamborlane WV. Impaired insulin action in puberty. *N Engl J Med*. 1986;315(4):215-219.
2. Van Walleghem N, MacDonald CA, Dean HJ. Evaluation of a systems navigator model for transition from pediatric to adult care for young adults with type 1 diabetes. *Diabetes Care*. 2008;31(8):1529-1530.
3. Spaic T, Robinson T, Goldbloom E, Gallego P, Hramiak I, Lawson ML, Malcolm J, Mahon J, Morrison D, Parikh A, Simone A, Stein R, Uvarov A, Clarson C; JDRF Canadian Clinical Trial CCTN1102 Study Group. Closing the gap: results of the multicenter Canadian randomized controlled trial of structured transition in young adults with type 1 diabetes. *Diabetes Care*. 2019;42(6):1018-1026.
4. Sequeira PA, Pyatak EA, Weigensberg MJ, Vigen CP, Wood JR, Ruelas V, Montoya L, Cohen M, Speer H, Clark S, Peters AL. Let's Empower and Prepare (LEAP): evaluation of a structured transition program for young adults with type 1 diabetes. *Diabetes Care*. 2015;38(8):1412-1419.
5. Kipps S, Bahu T, Ong K, Ackland FM, Brown RS, Fox CT, Griffin NK, Knight AH, Mann NP, Neil HAW, Simpson H, Edge JA, Dunger DB. Current methods of transfer of young people with type 1 diabetes to adult services. *Diabet Med*. 2002;19(8):649-654.
6. Lotstein DS, Seid M, Klingensmith G, Case D, Lawrence JM, Pihoker C, Dabelea D, Mayer-Davis EJ, Gilliam LK, Corathers S, Imperatore G, Dolan L, Anderson A, Bell RA, Waitzfelder B; SEARCH for Diabetes in Youth Study Group. Transition from pediatric to adult care for youth diagnosed with type 1 diabetes in adolescence. *Pediatrics*. 2013;131(4):e1062-e1070.
7. Grauslund J, Jørgensen TM, Nybo M, Green A, Rasmussen LM, Sjølie AK. Risk factors for mortality and ischemic heart disease in patients with long-term type 1 diabetes. *J Diabetes Complications*. 2010;24(4):223-228.
8. Bjerg L, Hulman A, Carstensen B, Charles M, Jørgensen ME, Witte DR. Development of microvascular complications and effect of concurrent risk factors in type 1 diabetes: a multistate model from an observational clinical cohort study. *Diabetes Care*. 2018;41(11):2297-2305.
9. Bryden KS, Dunger DB, Mayou RA, Peveler RC, Neil HAW. Poor prognosis of young adults with type 1 diabetes: a longitudinal study. *Diabetes Care*. 2003;26(4):1052-1057.
10. Schidlow DV, Fiel SB. Life beyond pediatrics. Transition of chronically ill adolescents from pediatric to adult health care systems. *Med Clin North Am*. 1990;74(5):1113-1120.
11. Peters A, Laffel L; American Diabetes Association Transitions Working Group. Diabetes care for emerging adults: recommendations for transition from pediatric to adult diabetes care systems: a position statement of the American Diabetes Association. *Diabetes Care*. 2011;34(11):2477-2485.
12. Tsamasiros J, Bartsocas CS. Transition of the adolescent from the children's to the adult's diabetes clinic. *J Pediatr Endocrinol Metab*. 2002;15:363-367.
13. Neu A, Lösch-Binder M, Ehehalt S, Schweizer R, Hub R, Serra E. Follow-up of adolescents with diabetes after transition from paediatric to adult care: results of a 10-year prospective study. *Exp Clin Endocrinol Diabetes*. 2010;118(6):353-355.

14. Petitti DB, Klingensmith GJ, Bell RA, Andrews JS, Dabelea D, Imperatore G, Marcovina S, Pihoker C, Standiford D, Waitzfelder B, Mayer-Davis E; SEARCH for Diabetes in Youth Study Group. Glycemic control in youth with diabetes: the SEARCH for Diabetes in Youth Study. *J Pediatr*. 2009;155:668-672.e1-e3.
15. Peters A, Laffel L; American Diabetes Association Transitions Working Group. Diabetes care for emerging adults: recommendations for transition from pediatric to adult diabetes care systems: a position statement of the American Diabetes Association. *Diabetes Care*. 2011;34(11):2477-2485.
16. Lyons SK, Becker DJ, Helgeson VS. Transfer from pediatric to adult health care: effects on diabetes outcomes. *Pediatr Diabetes*. 2014;15(1):10-17.
17. Soliman D, Crowley MJ, Manning A, Rikhi A, Chiswell K, Goldstein BA, Maslow G. Transition from pediatric to adult care in type 1 diabetes mellitus: a longitudinal analysis of age at transfer and gap in care. *BMJ Open Diabetes Res Care*. 2022;10(6):e002937.
18. Walch AM, Cobb CE, Tsaih SW, Cabrera SM. The medical transition of young adults with type 1 diabetes (T1D): a retrospective chart review identifies areas in need of improvement. *Int J Pediatr Endocrinol*. 2020;2020(1):1-10.
19. Butalia S, Crawford SG, McGuire KA, Dyjur DK, Mercer JR, Pacaud D. Improved transition to adult care in youth with type 1 diabetes: a pragmatic clinical trial. *Diabetologia*. 2021;64:758-766.
20. DeLacey S, Papadakis J, James S, Cudizio L, Ng SM, Lyons SK, Weissberg-Benchell J. A systematic review of interventions for the transition to adult healthcare for young people with diabetes. Curr Diab Rep. 2025;25(1):21.
21. Teló GH, Dougher CE, Volkening LK, Katz ML, Laffel LM. Predictors of changing insulin dose requirements and glycaemic control in children, adolescents and young adults with type 1 diabetes. *Diabet Med*. 2018;35(10):1355-1363.
22. Miller KM, Foster NC, Beck RW, Bergenstal RM, DuBose SN, DiMeglio LA, Maahs DM, Tamborlane WV; T1D Exchange Clinic Network. Current state of type 1 diabetes treatment in the U.S: updated data from the T1D Exchange clinic registry. *Diabetes Care*. 2015;38:971–978.
23. Cemeroglu AP, Thomas JP, Van Zande LT, Nguyen NT, Wood MA, Kleis L, Davis AT. Basal and bolus insulin requirements in children, adolescents, and young adults with type 1 diabetes mellitus on continuous subcutaneous insulin infusion (CSII): effects of age and puberty. *Endocr Pract.* 2013;19(5):805-811.
24. Conrad SC, McGrath MT, Gitelman SE. Transition from multiple daily injections to continuous subcutaneous insulin infusion in type 1 diabetes mellitus. *J Pediatr.* 2002;140(2):235-240.
25. Phillip M, Battelino T, Rodriguez H, Danne T, Kaufman F; Consensus Forum Participants. Use of insulin pump therapy in the pediatric age-group: consensus statement from the European Society for Paediatric Endocrinology, the Lawson Wilkins Pediatric Endocrine Society, and the International Society for Pediatric and Adolescent Diabetes, endorsed by the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care.* 2007;30(6):1653-1662.
26. Danne T, Von Schütz W, Lange K, Nestoris C, Datz N, Kordonouri O. Current practice of insulin pump therapy in children and adolescents–the Hannover recipe. *Pediatr Diabetes.* 2006;7(Suppl 4):25-31.
27. Rabbone I, Scaramuzza A, Bobbio A, Bonfanti R, Iafusco D, Lombardo F, Toni S, Tumini S, Cerutti F.Insulin pump therapy management in very young children with type 1 diabetes using continuous subcutaneous insulin infusion. *Diabetes Technol Ther.* 2009;11:707-709.
28. Klinkert C, Bachran R, Heidtmann B, Grabert M, Holl RW, DPV-Initiative. Age-specific characteristics of the basal insulin-rate for pediatric patients on CSII. *Exp Clin Endocrinol Diabetes.* 2008;116:118-122.
29. Pickup JC, Sutton AJ. Severe hypoglycaemia and glycaemic control in type 1 diabetes: meta-analysis of multiple daily insulin injections compared with continuous subcutaneous insulin infusion. *Diabet Med.* 2008;25(7):765-774.
30. White M, O'Connell MA, Cameron FJ. Clinic attendance and disengagement of young adults with type 1 diabetes after transition of care from paediatric to adult services (TrACeD): A randomized, open-label, controlled trial. *Lancet Child Adolesc Health.* 2017;1(4):274-283.
31. Busse FP, Hiermann P, Galler A, Stumvoll M, Wiessner T, Kiess W, Kapellen TM. Evaluation of patients' opinion and metabolic control after transfer of young adults with type 1 diabetes from a pediatric diabetes clinic to adult care. *Horm Res.* 2007;67(3):132-138.
32. Nakhla M, Daneman D, To T, Paradis G, Guttmann A. Transition to adult care for youths with diabetes mellitus: findings from a Universal Health Care System. *Pediatrics.* 2009;124:e1134–e1141.
33. Williams S, Newhook LAA, Power H, Shulman R, Smith S, Chafe R. Improving the transitioning of pediatric patients with type 1 diabetes into adult care by initiating a dedicated single session transfer clinic. *Clin Diabetes Endocrinol.* 2020;6:1-6.
34. Tremblay ES, Ruiz J, Buccigrosso T, Dean T, Garvey K. Health care transition in youth with type 1 diabetes and an A1C >9%: Qualitative analysis of pre-transition perspectives. *Diabetes Spectrum.* 2020;33(4):331-338.
35. Daneman D, Nakhla M. Moving On: Transition of Teens With Type 1 Diabetes to Adult Care. *Diabetes Spectrum.*2011;24(1):34-39.

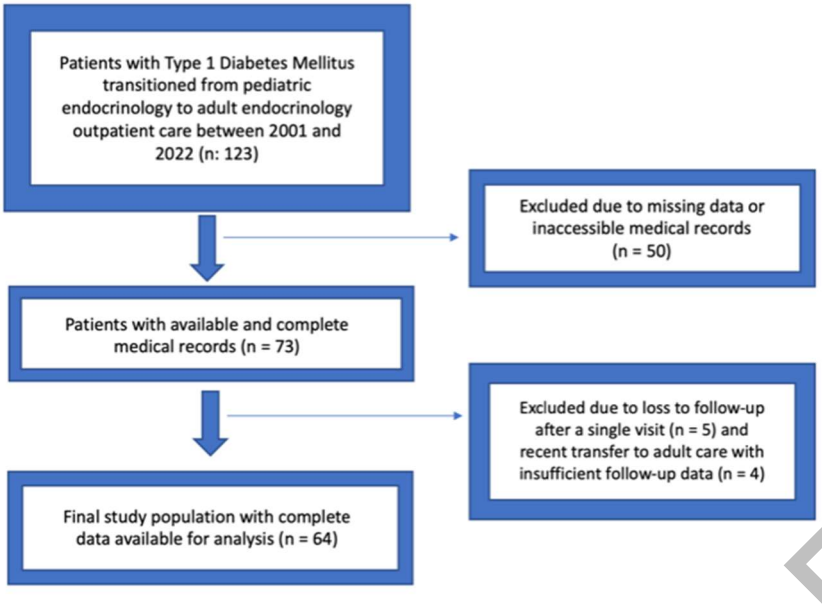

Figure 1. Flowchart of Patient Screening and Selection for the Study

Table 1: Comparison of Demographic and Anthropometric Data Before and After the Transfer in Individuals with Type 1 Diabetes Mellitus		
Demographics and Anthropometry	**Last Pediatric Evaluation (n=64)**	**Post-Transition Evaluation (n=64)**
Gender n (%)		
Female	28 (43.7%)	
Male	36 (56.3%)	
Age (years) (mean ± SD)	19,36 ± 1,29	23.3 ± 4.2
Body Weight (kg) (mean ± SD)	68.5 ± 13.5	71.7 ± 22.0
Body Mass Index (kg/m²) (mean ± SD)	24.1 ± 1.65	23.5 ± 3.5
Body Mass Index categories n (%):		
Normal	43 (67.2%)	44 (68.7%)
Overweight	20 (31.2%)	14 (21.8%)
Obese	1 (1.6%)	6 (9.3%)
Note: Data are presented as mean ± standard deviation or frequency. This table provides descriptive comparisons between the last pediatric evaluation and the last adult visit.		

Table 2. Comparison of Clinical Parameters Between Pediatric and Adult Follow-Up Periods			
Clinical Parameters	**Pediatric Follow-Up (n=64)**	**Adult Follow-Up (n=64)**	**p-value**
Follow-up duration (years) (mean ± SD)	10.6 ± 4.1	3.1 ± 4.2	<0.0001
Number of visits/year (mean ± SD)	3.0 ± 0.9	2.1 ± 1.8	0.009
HbA1c (last year) (%) (mean ± SD)	8.95 ± 1.6	8.3 ± 1.6	0.007
Knows carbohydrate counting n (%)	34 (53.1%)	35 (55.6%)	0.78
Practices carbohydrate counting n (%)	25 (39.7%)	24 (38.1%)	0.85
Insulin dose (IU/kg/day) (mean ± SD)	0.95 ± 0.3	0.75 ± 0.34	<0.0001
Basal insulin ratio (%) (mean ± SD)	43.1 ± 10.8	52.8 ± 11.3	<0.0001
Insulin therapy modality			
Multiple daily doses n (%)	61 (95.3%)	56 (87.5%)	0.011
Continuous subcutaneous insulin therapy n (%)	3 (4.7%)	8 (12.5%)	
Note: Follow-up duration and annual number of visits represent average values across the pediatric and adult care periods. HbA1c refers to the mean of the final year in each period. Knowledge and practice of carbohydrate counting, insulin treatment model, insulin dose, and basal insulin ratio were assessed based on the last recorded visit in each setting.			

Table 3: Evaluation of Comorbidities and Complications Before and After the Transition in Individuals with Type 1 Diabetes Mellitus			
Comorbidities	**Before Transition**	**After Transition**	**p-value**

Celiac disease n (%)	2 (3.1%)	2 (3.3%)	0.96
Hashimoto thyroiditis n (%)	15 (23.4%)	14 (25.9%)	0.75
Complications	**Before Transition**	**After Transition**	**p-value**
Nephropathy n (%)	8 (12.5%)	11 (18%)	0.389
Retinopathy n (%)	1 (1.6%)	3 (4.9%)	0.286
Neuropathy n (%)	2 (3.1%)	4 (6.6%)	0.369
Hyperlipidemia n (%)	8 (12.5%)	13 (21.3%)	0.187
DKA episodes (mean ± SD)	0.2 ± 0.64	0.2 ± 0.64	0.103
DKA: Diabetic ketoasidosis			

Supplementary Table S1. Clinical Parameters in Patients With ≤4 Years of Adult Follow-up

Clinical Parameters	Pediatric Follow-Up (n=48)	Adult Follow-Up (n=48)	p-value
Follow-up duration (years) (mean ± SD)	10.10 ± 3.70	2.60 ± 0.90	<0.001
Number of visits/year (mean ± SD)	2.90 ± 0.70	2.30 ± 0.70	0.039
HbA1c (last year) (%) (mean ± SD)	8.85 ± 1.63	8.36 ± 1.86	0.047
Knows carbohydrate counting n (%)	33 (68.8%)	26 (54.2%)	0.002
Practices carbohydrate counting n (%)	21 (43.8%)	18 (37.5%)	0.003
Insulin dose (IU/kg/day) (mean ± SD)	0.87 ± 0.27	0.80 ± 0.27	<0.001
Basal insulin ratio (%) (mean ± SD)	44.15 ± 12.41	51.20 ± 11.61	<0.001
Insulin therapy modality			
Multiple daily doses n (%)	46 (95.8%)	43 (89.6%)	0.009
Continuous subcutaneous insulin therapy n (%)	2 (4.2%)	5 (10.4%)	

Supplementary Table S2. Comparison of Transition Models

Transition Model	Model 1 (n=36)	Model 2 (n=24)	p-value
Average HbA1c (%n)			
Pediatric period	8.62±1.36	9.11±1.30	0.179 [a]
Adult period	8.40±1.27	8.55±1.54	0.709 [a]

HbA1c difference	-0.62±10.40	9.23±14.72	0.092 [a]
Average number of visits (n/year)			
Pediatric period	3 (2:6)	3 (2:6)	0.637 [b]
Adult period	2 (0:11)	2 (0:6)	0.540 [b]
Visit number difference	-1 (-4:7)	-1 (-6:2)	0.262 [b]
BMI (kg/m²)			
Pediatric period	22.61±3.37	23.66±3.01	0.231 [a]
Adult period	23.07±3.55	24.43±3.48	0.162 [a]
BMI difference	1.83 (-17.36:37.61)	1.58 (-13.04:33.93)	0.790 [b]
Average insulin dose (IU/kg/day)			
Pediatric period	0.93±0.30	0.92±0.25	0.866 [a]
Adult period	0.76 (0:1.25)	0.76 (0:1.40)	0.756 [b]
Insulin dose change	-15.41 (-100:43.06)	-6.40 (-100:72.84)	0.346 [b]
Knows carbohydrate counting n (%)			
Pediatric period	21 (50%)	10 (45.5%)	
Adult period	21 (50%)	12 (54.5%)	
Comparison of differences			0.730 [c]
Practices carbohydrate counting n (%)			
Pediatric period	16 (51.6%)	7 (50%)	
Adult period	15 (48.4%)	7 (50%)	
Comparison of differences			0.920 [c]
Use of CSII n (%)			
Pediatric period	0 (0 %)	2 (40 %)	
Adult period	3 (100 %)	3 (60 %)	
Comparison of differences			0.464 [d]
Use of MDI n (%)			
Pediatric period	36 (52.1 %)	22 (51.1 %)	
Adult period	33 (47.9 %)	21 (48.8 %)	
Comparison of differences			> 0,99 [d]
Use of CGM n (%)			
Pediatric period	2 (50 %)	2 (40 %)	
Adult period	2 (50 %)	3 (60 %)	
Comparison of differences			0.380 [d]
Hyperlipidemia n (%)			
Pediatric period	4 (44.4%)	4 (36.4%)	
Adult period	5 (55.6%)	7 (63.6%)	
Comparison of differences			>0.99 [d]
Retinopathy n (%)			
Pediatric period	1 (50%)	0	
Adult period	1 (50%)	2 (100%)	
Comparison of differences			>0.99 [d]
Nephropathy n (%)			
Pediatric period	4 (40%)	3 (42.9%)	
Adult period	6 (60%)	4 (57.1%)	
Comparison of differences			>0.99 [d]
Neuropathy n (%)			
Pediatric period	0	2 (50%)	
Adult period	1 (100%)	2 (50%)	
Comparison of differences			>0.99 [d]

BMI: body mass index
Data are expressed as mean±std. deviation and median (minimum–maximum) a: Independent sample t test, b: Mann Whitney U test, c: Pearson Chi-squared test, d: Fisher's Exact test

Supplement Table S3. Model Comparison in Patients With ≤4 Years of Adult Follow-up

Transition Model	Model 1 (n=27)	Model 2 (n=17)	p-value
Average HbA1c (%n)			
Pediatric period	9.02±1.47	8.90±1.29	0.780 [a]
Adult period	8.66±1.78	8.08±1.99	0.506 [a]
HbA1c difference	0.21±0.99	0.75±1.06	0.262 [a]
Average number of visits (n/year)			
Pediatric period	3,0 (2,0:6,0)	3,0 (2,0:4,0)	0.025 [b]
Adult period	2,0 (0,0:11,0)	2,0 (1,0:7,0)	0.206 [b]
Visit number difference	2,0 (-7,0:6,0)	1,0 (-4,0:2,0)	0.014 [b]
BMI (kg/m²)			
Pediatric period	22.43±3.26	23.81±2.93	0.163 [a]
Adult period	22.86±3.51	23.18±3.27	0.763 [a]
BMI difference	-0.4 (-8.2:4.2)	0.6 (-4.0:3.1)	0.122 [b]
Average insulin dose (IU/kg/day)			

Pediatric period	0.91±0.27	0.93±0.36	0.546 [a]
Adult period	0.83 (0:1.36)	0.78 (0:1.25)	0.941 [b]
Insulin dose change	-0.09 (-0,59:4.38)	-0.05 (-0,13:0.97)	0.357 [b]
Knows carbohydrate counting n (%)			
Pediatric period	18 (66,7%)	8 (47.1%)	0.198 [c]
Adult period	15 (55,6%)	9 (52.9%)	0.865 [c]
Practices carbohydrate counting n (%)			
Pediatric period	13 (72.2%)	5 (31,3%)	0.278 [c]
Adult period	11 (68.8%)	5 (31,3%)	0.447 [c]
Use of CSII n (%)			
Pediatric period	0	1 (100%)	1.000 [d]
Adult period	1 (50%)	1 (50%)	1.000 [d]
Hyperlipidemia n (%)			
Pediatric period	5 (71.4%)	2 (28.6%)	0.689 [d]
Adult period	5 (50.0%)	5 (50.0%)	0.714 [d]
Retinopathy n (%)			
Pediatric period	1 (100%)	0	1.000 [d]
Adult period	1 (50.0%)	1 (50.0%)	1.000 [d]
Nephropathy n (%)			
Pediatric period	2 (66,7%)	1 (33.3%)	1.000 [d]
Adult period	2 (66.7%)	1 (33.3%)	1.000 [d]
Neuropathy n (%)			
Pediatric period	0	1 (100%)	0.386 [d]
Adult period	0	1 (100%)	0.415 [d]

BMI: body mass index
Data are expressed as mean±std. deviation and median (minimum–maximum) a: Independent sample t test, b: Mann Whitney U test, c: Pearson Chi-squared test, d: Fisher's Exact test