

# Measuring the Transition Readiness of Adolescents With Type 1 Diabetes Using the Transition Readiness Assessment Questionnaire

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**■ IN BRIEF** This study aimed to assess readiness to transition from pediatric to adult health care in adolescents with type 1 diabetes using the Transition Readiness Assessment Questionnaire (TRAQ). TRAQ is a non-disease-specific self-report measure that assesses self-management and advocacy skills of youth with special health care needs. This study provides guidance on assessing transition readiness scores of adolescents with diabetes and identifying when health care providers should intervene.

The incidence of type 1 diabetes is increasing globally. In the United States, the prevalence of type 1 diabetes increased an average of 0.08% every 4 years during the 12-year period from 1999 to 2010 (1). Findings from the SEARCH for Diabetes in Youth study for 2002–2005 showed that, among children  $\geq 10$  years of age in the United States, the rate of newly diagnosed type 1 diabetes was 18.6/100,000 each year (1). The increase in prevalence directly correlates with an increase in type 1 diabetes–related annual health care costs. According to the American Diabetes Association (ADA), the largest components of medical expenditures in 2017 among patients with diabetes were hospital inpatient care and prescription medications to treat complications of diabetes (2). Adolescents with type 1 diabetes with ineffective transitioning from pediatric to adult care are at risk for delayed and irregular medical follow-up care, which increases the incidence of acute and chronic diabetes complications (3). Thus, to reduce the overall health care costs of type 1 diabetes and its complications in adolescents, it is important to create a smooth process for that transition.

The ADA has a position statement offering recommendations for health care delivery during this transition period (4). “Got Transition” is a national effort whose aim is to improve the transition process by providing resources to all adolescents, their families, and their health care providers (HCPs) (5). Yet, despite the availability of national recommendations and resources, the problem of ineffective transition of care for adolescents with type 1 diabetes persists (6–8). Earlier research has highlighted suboptimal transition preparation as one of the challenges in the transition process (9). Additionally, based on the 2016 National Survey of Children’s Health, only an estimated 17% of youth with special health care needs received appropriate transition planning support, and 69% of HCPs actively worked with patients to develop self-care skills by the age of 18 years (10).

Previous research has emphasized the need for an individualized approach to transition planning in adolescents with type 1 diabetes (4,9,11). One major challenge is the lack of well-defined criteria for determining transition readiness (4). Limited research has been done in the

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area of assessing transition readiness, and there are only a few validated instruments to measure it.

The Transition Readiness Assessment Questionnaire (TRAQ) is the first skill-focused, self-report tool for assessing the developmental stage of transition readiness for youth with chronic medical conditions, including diabetes. It measures patients' readiness in five different domains: managing medications, appointment keeping, tracking health issues, talking with providers, and managing daily activities (12–14). These domains represent the skills essential for self-management and health care utilization for chronic medical conditions. Self-management skills are complex to understand but important to improve the self-care actions of adolescents (15). Other validated transition-related tools include the STARx Questionnaire transition readiness tool and the TRxANSITION Index. The latter is designed to be administered by a trained professional and is composed of 32 items, whereas the former is designed to be self-administered and includes 18 items. However, there have been no studies using these tools in adolescents with type 1 diabetes.

Although the TRAQ has been validated in youth with special health care needs, only one limited study considered only youth with type 1 diabetes patients alone (12,13). This research aims to determine the association of demographic factors such as age and sex and clinical factors such as A1C with the self-advocacy and self-management skills of adolescents with type 1 diabetes, using the TRAQ tool. The ADA recommends that transition preparation begin during early adolescence (9). This study will assist HCPs in developing strategies and interventions to improve transition readiness in adolescent patients with type 1 diabetes by allowing them to better understand the factors affecting and variation in patients' baseline TRAQ transition readiness scores.

## Methodology

### Study Sample and Design

Retrospective medical record review was conducted of patients with type 1 diabetes from the University of Illinois Hospital and Health Science System (UI Health) and Rush University Medical Center (RUMC) between July 2016 and June 2017. The TRAQ tool is being used in both institutions; hence, it was practical to use it for a retrospective study. The patient sample included 95 adolescents between the ages of 14 and 19 years with type 1 diabetes. The TRAQ was provided to patients as a part of their routine clinical assessment. It was self-administered with pen and paper and then scanned into their medical record. In addition to TRAQ scores, patients' age, sex, duration since diabetes diagnosis, most recent A1C within the previous 6 months, and comorbidities were collected from their medical records. Inclusion criteria included adolescents aged 14–19 years who had had type 1 diabetes for >6 months. Adolescents with intellectual disabilities or comorbid conditions not related to diabetes were excluded from the study because such conditions may have affected their transition readiness score. This study was approved by the institutional review boards at both hospitals.

As previously mentioned, TRAQ assesses five domains of patient readiness for transition: managing medications, appointment keeping, tracking health issues, talking with providers, and managing daily activities. It includes 20 items, which patients answer by selecting numbers from a 5-point Likert scale in which 1 = “No, I do not know how,” 2 = “No, but I want to learn,” 3 = “No, but I am learning to do this,” 4 = “Yes, I have started doing this,” and 5 = “Yes, I always do this when I need to.”

### Statistical Analysis

Descriptive statistics were computed for the total analytic sample. Mean scores of TRAQ domains were determined for the adolescents. Significant

mean differences in overall TRAQ scores and in scores for managing medications and appointment keeping domain were computed by *t* test or one-way analysis of variance (ANOVA) testing, whereas for the tracking health issues, talking to providers, and managing daily activities domains, mean differences were determined by Wilcoxon rank sum test or Kruskal Wallis test. Multivariable linear regression was performed to demonstrate the relationship of age, sex, or A1C with overall TRAQ scores. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, N.C.), and *P* values ≤0.05 were considered statistically significant.

## Results

The distribution of demographic and clinical factors is shown in Table 1. Among the adolescents aged 14–19 years with type 1 diabetes in this sample, there was an almost equal distribution of males and females. The majority of study participants were 14–15 years of age and had an A1C between 7.5 and 10%.

The means of overall TRAQ scores and individual domain scores for our analytic sample are shown in Table 2.

**TABLE 1. Sample Characteristics of Adolescents With Type 1 Diabetes (n = 95)**

Characteristic	n (%) or mean ± SD
Sex	
Male	49 (51.6)
Female	46 (48.4)
Age, years	
14–15	41 (43.2)
16–17	34 (35.8)
18–19	18 (19.0)
Mean age, years	15.9 ± 1.9
A1C, %	
<7.5	10 (10.5)
7.5–10	43 (45.3)
10–12.5	26 (27.4)
>12.5	16 (16.9)
Mean A1C, %	9.9 ± 2.1

**TABLE 2. Mean Individual Domain and Overall TRAQ Scores of Adolescents With Type 1 Diabetes**

TRAQ Domains	Score, mean $\pm$ SD
Managing medications	3.8 $\pm$ 0.9
Appointment keeping	2.8 $\pm$ 1.1
Tracking health issues	2.9 $\pm$ 1.1
Talking with providers	4.5 $\pm$ 0.9
Managing daily activities	4.4 $\pm$ 0.6
Overall TRAQ score	3.7 $\pm$ 0.7

The adolescents in this sample scored low on appointment keeping and tracking health issues but seemed confident in talking with providers.

The mean difference in scores for the TRAQ domains of managing medications, appointment keeping, and tracking health issues, by age, sex, and A1C, are shown in Table 3. The mean difference in scores for the TRAQ domains of talking with providers and managing daily activities, as well as the mean difference in overall TRAQ scores, by age, sex, and A1C are shown in Table 4. Females had significantly higher overall TRAQ score compared to males (mean 3.9 vs. 3.5,  $P = 0.01$ ).

For better understanding and visualization of results, line graphs were

made. Figure 1 presents the mean score in each domain of TRAQ by sex among adolescents with type 1 diabetes. Managing daily activities scores were significantly different between sexes, such that females had higher mean scores compared to males (Table 4). Figure 2 presents the mean score of TRAQ domains by age-group. The age-group of 18–19 years scored higher than their younger counterparts in appointment keeping (Table 3). Figure 3 presents the mean score of TRAQ domains by A1C. No significant differences were noted.

In multivariate linear regression for overall TRAQ scores, age, sex, and A1C were used as independent variables. Females were associated with a higher score than males after

adjusting for age and A1C ( $P = 0.03$ ). Females scored higher in overall mean TRAQ by 0.31 compared to males. For every 1-year increase in age, there was an increase in overall TRAQ score of 0.03 after adjusting for A1C and sex. With an increase in A1C of 1%, the overall TRAQ score was increased by 0.06 after adjusting for age and sex. However, statistical significance was not determined (Table 5).

## Discussion

This study signifies the demographic factors (i.e., age and sex) that should be considered in understanding and measuring the transition readiness of adolescents with type 1 diabetes. In previous studies of chronic health conditions, the self-advocacy domain of TRAQ did not differ by sex. However, in this study, the mean overall baseline TRAQ among adolescents with type 1 diabetes differed by sex such that females demonstrated greater transition readiness by being more confident in their self-management and self-advocacy skills than males (16). This finding is supported by a study of youth with special health care needs, in which higher overall TRAQ

**TABLE 3. Mean Differences in Scores for TRAQ Domains of Managing Medications, Appointment Keeping, and Tracking Health Issues by Sex, Age, and A1C of Adolescents With Type 1 Diabetes**

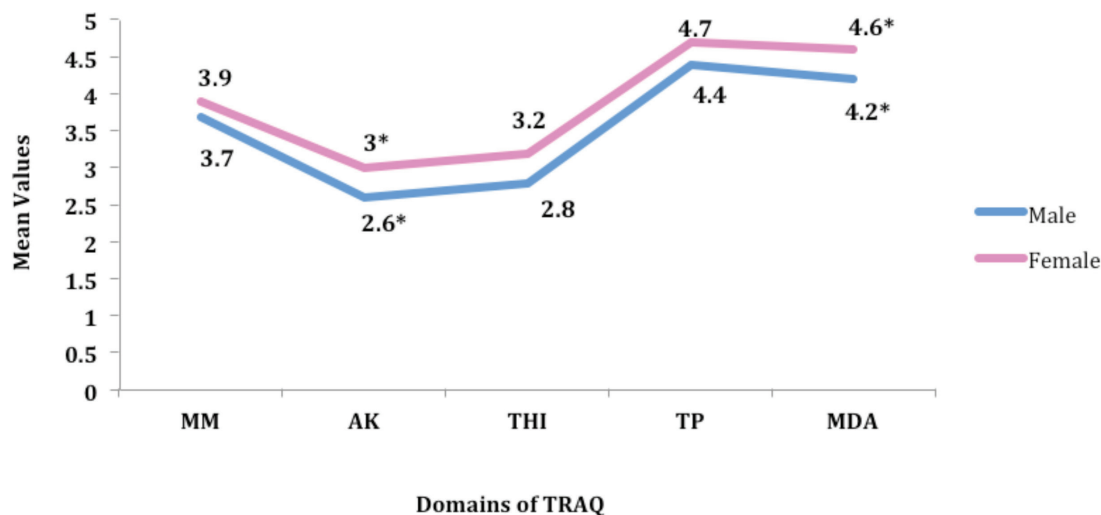
Variables	Managing Medications, mean $\pm$ SD	$P^*$	Appointment Keeping, mean $\pm$ SD	$P^*$	Tracking Health Issues, mean $\pm$ SD	$P^\dagger$
Sex		0.11		0.06		0.11
Male	3.7 $\pm$ 0.9		2.6 $\pm$ 1.0		2.8 $\pm$ 1.2	
Female	3.9 $\pm$ 0.9		3.0 $\pm$ 1.2		3.2 $\pm$ 1.0	
Age, years		0.07		0.001‡		0.14
14–15	3.8 $\pm$ 0.9		2.7 $\pm$ 1.2		2.8 $\pm$ 1.2	
16–17	3.6 $\pm$ 0.8		2.5 $\pm$ 0.9		2.8 $\pm$ 1.0	
18–19	4.2 $\pm$ 0.9		3.6 $\pm$ 1.1		3.4 $\pm$ 1.2	
A1C, %		0.29		0.06		0.59
<7.5	3.4 $\pm$ 1.1		2.4 $\pm$ 0.9		2.6 $\pm$ 1.2	
7.5–10	3.8 $\pm$ 0.8		2.6 $\pm$ 1.0		3.0 $\pm$ 1.1	
10–12.5	3.9 $\pm$ 0.9		3.0 $\pm$ 1.1		2.9 $\pm$ 1.1	
>12.5	4.1 $\pm$ 0.8		3.3 $\pm$ 1.4		3.2 $\pm$ 1.2	

\*Significant mean differences in scores for managing medications and appointment keeping were assessed by  $t$  test or one-way ANOVA. †Significant mean differences in scores for tracking health issues were assessed by Wilcoxon rank sum test or Kruskal Wallis test. ‡Statistically significant.

**TABLE 4. Mean Differences in Scores for TRAQ Domains of Talking With Providers and Managing Daily Activities and in Overall TRAQ Scores by Sex, Age, and A1C of Adolescents With Type 1 Diabetes**

Variables	Talking With Providers, mean ± SD	P†	Managing Daily Activities, mean ± SD	P†	Overall TRAQ Score, mean ± SD	P*
Sex		0.29		0.001‡		0.01‡
Male	4.4 ± 1.1		4.2 ± 0.7		3.5 ± 0.7	
Female	4.7 ± 0.6		4.6 ± 0.5		3.9 ± 0.7	
Age, years		0.34		0.69		0.09
14–15	4.7 ± 0.5		4.5 ± 0.5		3.7 ± 0.6	
16–17	4.4 ± 0.9		4.4 ± 0.8		3.5 ± 0.7	
18–19	4.4 ± 1.4		4.3 ± 0.7		4.0 ± 0.9	
A1C, %		0.23		0.75		0.19
<7.5	4.2 ± 1.4		4.3 ± 0.8		3.4 ± 0.9	
7.5–10	4.7 ± 0.6		4.4 ± 0.7		3.7 ± 0.6	
10–12.5	4.3 ± 0.6		4.4 ± 0.6		3.7 ± 0.7	
>12.5	4.8 ± 0.4		4.5 ± 0.6		4.0 ± 0.8	

\*Significant mean differences in scores for overall TRAQ were assessed by t test or one-way ANOVA. †Significant mean differences in scores for talking with providers and managing daily activities were assessed by Wilcoxon rank sum test or Kruskal Wallis test. ‡Statistically significant.



■ **FIGURE 1.** Mean score of TRAQ by sex among adolescents with type 1 diabetes. AK, appointment keeping; MDA, managing daily activities; MM, managing medication; THI, tracking health issues; TP, talking to providers.

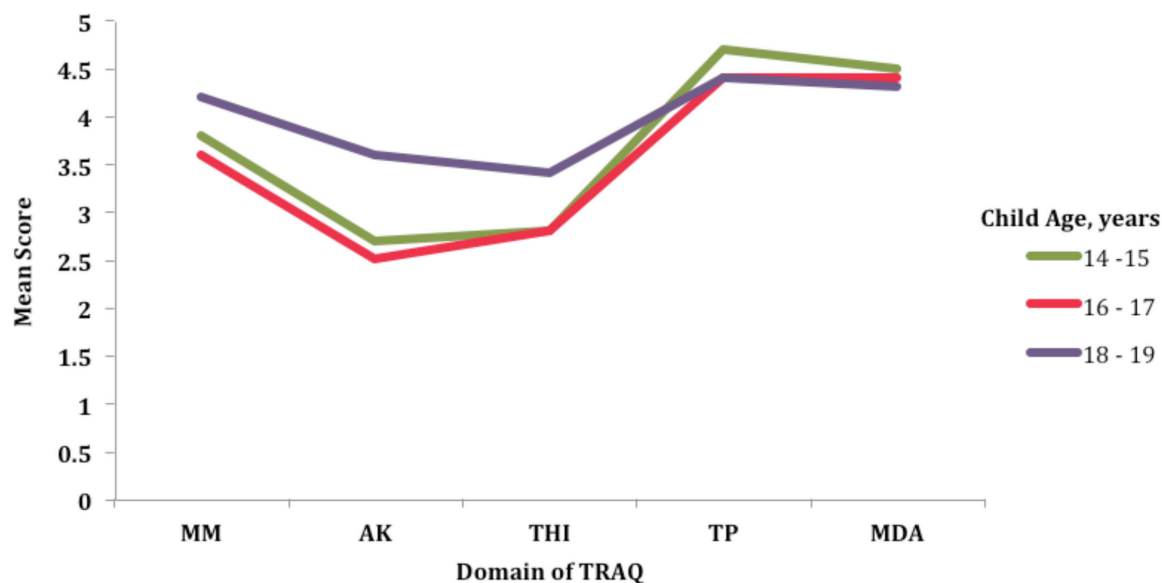
scores were found in females, likely because of greater developmental maturity (17).

Scores in the appointment keeping domain were significantly different among age-groups. This result indicates that some self-management skills are gained with age and can be enhanced by education interventions

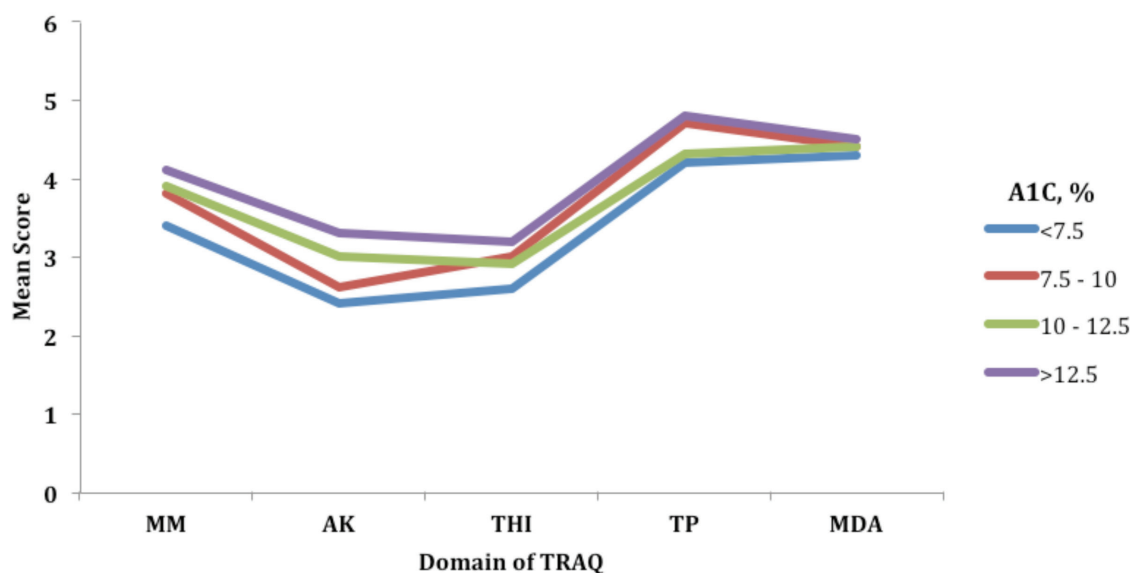
with specific goals targeting distinctive age-groups. However, in contrast to the study of youth with special health care needs, overall TRAQ scores were not significantly different (17). This finding indicates that interventions to build some skills such as managing medications and tracking health issues can be started early in

adolescence since it may take several years for patients to feel ready to manage their chronic conditions. Future longitudinal studies can evaluate the impact of such interventions on TRAQ scores.

To our knowledge, this is the first study to examine the association of A1C and transition readiness



**FIGURE 2.** Mean score of TRAQ by age of adolescents with type 1 diabetes. AK, appointment keeping; MDA, managing daily activities; MM, managing medication; THI, tracking health issues; TP, talking to providers.



**FIGURE 3.** Mean score of TRAQ by A1C of adolescents with type 1 diabetes. AK, appointment keeping; MDA, managing daily activities; MM, managing medication; THI, tracking health issues; TP, talking to providers.

scores assessing self-management and self-advocacy skills, which was found to be insignificant. This finding contradicts the hypothesis that there would be a correlation between higher TRAQ score and lower A1C (18). However, the sample size was small with the restricted population of those who came for a routine clinical visit at UI Health or RUMC.

**TABLE 5. Multivariate Regression Analysis of TRAQ**

Variables	Overall TRAQ	
	Parameter Estimate	P
Age	0.03	0.43
A1C	0.06	0.06
Female sex	0.31	0.03*
Adjusted R <sup>2</sup>	0.07	—

\*Statistically significant P value.

Thus, further studies are required to understand the relationships between A1C and TRAQ scores. Nonetheless, the mean A1C in our sample was 9.9%, which is more than the target level (i.e., <7.5%), which emphasizes the need for increased efforts regarding transition planning and care for adolescents with type 1 diabetes.

In line with previous studies (12,18), low mean scores were found in appointment keeping and tracking health issues. This finding highlights the need for individualized interventions focused on these skills.

### Limitations

The sample size of this study was very small and also from only two medical centers. Selection bias could have been present because only patients who came for routine assessment were part of the study. An intrinsic limitation of TRAQ is that it is a measure of general transition readiness and is not specific to diabetes. Although TRAQ was designed as a self-reported tool, intervention by parents cannot be excluded. Factors such as the difference in treatments (e.g., insulin pump vs. multiple daily insulin injections or types of insulin used) were not taken into consideration in assessing transition readiness and could have been responsible for the difference in baseline TRAQ scores. To determine an accurate association of factors with transition readiness score, future studies should include adolescents with type 1 diabetes from different medical centers and include possible socio-demographic and clinical factors such as race, education, and income level.

### Conclusion

Overall transition readiness scores taking into account both self-management and self-advocacy skills vary by sex, whereas the specific appointment keeping readiness domain varies by the age of adolescents with type 1 diabetes. A1C was not associated with the overall or any specific domains of TRAQ. However, further

research is needed to confirm the finding regarding A1C and transition readiness. HCPs can strategize the development of education interventions such as a reminder for follow-up appointments and discussions about the medications and side effects to improve the skills of adolescents with type 1 diabetes based on their age, sex, and baseline TRAQ scores.

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### Duality of Interest

No potential conflicts of interest relevant to this article were reported.

### Previous Presentation

An abstract of this study was presented as a poster at the 2018 Endocrine Society meeting in Chicago, Ill.

### Author Contributions

J.T.C. wrote the manuscript and researched data. J.S. performed statistical analysis, wrote the results, and contributed to the introduction and discussion. D.S. contributed to the introduction and discussion. S.M. assisted in collecting and evaluating the data, contributed to the discussion, and reviewed and edited the manuscript. C.B.-B. reviewed and edited the manuscript. J.T.C. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of data analysis.

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