FEATURE ARTICLE

A Brief Nutrition Questionnaire for Children With Newly Diagnosed Type 1 Diabetes

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Carbohydrate counting is an important component of type 1 diabetes management that is taught at the time of diagnosis. We implemented and validated a nutrition quiz to assess fundamental carbohydrate counting and nutrition knowledge in newly diagnosed patients. An interactive standard assessment for newly diagnosed type 1 diabetes patients was feasible and reliable to implement for patients and caregivers, but participants with public insurance scored lower overall. This assessment may help to identify nutrition knowledge gaps and provide opportunities for timely education, and providers should place additional focus on nutrition education for patients with public insurance.

KEY POINTS

- Carbohydrate counting is an important component of type 1 diabetes management.
- A brief, interactive quiz may help to identify nutrition knowledge gaps in patients with new-onset type 1 diabetes.
- This interactive quiz can be administered to patients and/or caregivers, as appropriate for the patient's age.
- Additional nutrition education should be provided to patients with public insurance.

Type 1 diabetes, one of the most common chronic childhood diseases, is an autoimmune disorder characterized by loss of insulin-producing β-cells in the pancreas (1). Management of type 1 diabetes has been marked by major advances over the past two decades, with the use of diabetes technologies for intensive insulin therapy and blood glucose monitoring (2). Yet, carbohydrate counting remains an essential component of nutrition management in type 1 diabetes care (3,4). Carbohydrate counting allows for matching prandial insulin doses to carbohydrate intake and is associated with flexibility in carbohydrate intake at mealtimes and improvements in glycemic control and quality of life (4–6).

The International Society for Pediatric and Adolescent Diabetes (ISPAD) guidelines for nutrition management in youth with diabetes recommends that nutrition education be provided at the time of diabetes diagnosis, preferably by a specialized diabetes dietitian as part of a larger multidisciplinary diabetes team (4). Thus, nutrition education typically occurs during the primary hospitalization for new-onset diabetes and is reinforced during subsequent outpatient diabetes clinic visits (4,7). Given that the time of diagnosis is a very stressful period for patients and their families, it is difficult to ascertain how much of that initial nutrition education and knowledge is retained. Ongoing nutrition education is necessary, especially in the first year after diagnosis, to address the fundamentals and complexities of nutrition management in diabetes, considering aspects such as carbohydrate counting, glycemic index, and fat and protein content of meals (4,8).

A prior randomized trial demonstrated that interactive nutrition education is more effective than standard lecture-style education for children and adolescents (9). Furthermore, a review of pediatric diabetes nutrition education suggests that carbohydrate counting education should engage the child with the use of visual models, food models, and pictures (3). Several nutrition assessments have been developed to assess carbohydrate and insulin dosing knowledge in clinical research and

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practice, including the 78-item PedsCarbQuiz (10), the 23-item Diabetes Nutrition Knowledge Survey (11), the 19-item electronic NutraCarbQuiz (12), the 19-item Mercy What I Know About Diabetes (13), and brief 5-item questionnaires developed by our group (14). In general, higher assessment scores correlated with lower A1C levels and better glycemic control (10–13). Although several nutrition assessments exist, they are time intensive and include advanced nutrition education topics. Given the distress associated with a new diagnosis of type 1 diabetes and the difficulty patients and families may have retaining new information during this time, we sought to develop and validate a nutrition assessment of fundamental concepts to assess knowledge and knowledge gaps in recently diagnosed patients with type 1 diabetes.

Research Design and Methods

Participants

This prospective study was implemented as a quality improvement project at the Johns Hopkins Pediatric Diabetes Center in Baltimore, MD, between September 2020 and August 2021. Eligible participants were children who were 2–17 years of age, recently diagnosed with type 1 diabetes, and attending either their first or second outpatient diabetes visit after a new diagnosis of type 1 diabetes. The Johns Hopkins Institutional Review Board approved this study with a waiver of consent, according to the Declaration of Helsinki.

Assessment Development

The 16-item nutrition and carbohydrate counting assessment was developed by experts at the Johns Hopkins Medical Institute, including two pediatric endocrinologists and registered dietitians, who were involved in the administration of the assessment. The Flesch-Kincaid readability grade level for the assessment was calculated as 5.4.

Assessment Administration and Scoring

The assessment was administered by a dietitian to either the participant, the participant's caregiver, or both the participant and the caregiver together. The assessment was conducted during a nutrition visit that occurred at the participant's first or second comprehensive outpatient diabetes visit. If the visit occurred in person, the assessment was administered with paper and pencil. If it was a telemedicine visit, which occurred more frequently during the beginning of the coronavirus disease 2019 (COVID-19) pandemic, the assessment was sent electronically via the MyChart interface for the patient/caregiver to complete during the virtual nutrition visit. The assessments were scored by points, and the duration it took to complete the assessment was timed. The assessment included four sections: "Insulin" (five total points), "Nutrition" (four total points), "Using a Nutrition Facts Label" (five total points), and "Symptoms and Complications" (two total points). The final score was determined by adding all the points scored from each section with a maximum total of 16 points.

Reliability and Validation of Assessment

Face validity was established by a multidisciplinary team consisting of pediatric endocrinologists and registered dietitians/certified diabetes care and education specialists. Internal consistency between the four quiz sections was measured using Cronbach's α. The standardized coefficient of 0.80 reflected overall good internal reliability.

Data Collection

Data regarding patients' age, sex, race, ethnicity, use of continuous glucose monitoring (CGM), insurance type (categorized as commercial insurance or public insurance [Medicaid]), primary language, type of outpatient visit (in person or via telemedicine), and hospital length of stay were collected from the electronic medical record. Point-of-care A1C tests were performed using the Afinion As100 Analyzer. The collection of A1C levels occurred during patients' initial hospitalization at the diagnosis of type 1 diabetes, as well as during the corresponding outpatient visit before the administration of the assessment.

Statistical Analysis

Descriptive statistics of the collected variables are reported as means and SDs or frequency and percentage. The nutrition quiz results were not normally distributed, so Wilcoxon rank sum or Kruskal-Wallis tests were conducted to compare unadjusted quiz values between groups. Those with ≥75% of answers correct were considered to have a passing score. Logistic regression was used to identify predictors associated with passing the quiz. SAS, v. 9.4, software was used for all statistical analysis.

Results

Participants

A total of 41 participants with recently diagnosed type 1 diabetes were included. As shown in Table 1, the average age of participants was 9.3 ± 3.8 years (range 2–17 years), 58.5% were male, and 82.9% had commercial insurance. Non-Hispanic Whites comprised 75.6% of

TABLE 1 Descriptive Statistics for Participants Completing the Nutrition Survey (*N* = 41)

Variable	Value
Age, years	9.3 ± 3.8
Male sex	24 (58.5)
Insurance type	
Commercial	34 (82.9)
Medicaid	7 (17.1)
Race/ethnicity	
Non-Hispanic White	31 (75.6)
Non-Hispanic Black	8 (19.5)
Hispanic	2 (4.9)
Length of hospitalization, days*	2.7 ± 0.9
A1C at diagnosis, %	11.8 ± 2.2
Time from diagnosis to quiz 1, days	46.9 ± 28.6
A1C at quiz 1, % (*n* = 39)†	8.7 ± 1.6
Using CGM	21 (51.2)
Virtual visit	5 (12.2)
Quiz completed by:	
Caregiver	24 (58.5)
Participant	6 (14.6)
Caregiver and participant	11 (26.8)
Nutrition time spent in clinic, minutes	22.2 ± 6.8
Quiz score	
Total (out of 16)	13.4 ± 3.1
Insulin subscore (out of 5)	4.1 ± 1.4
General nutrition subscore (out of 4)	3.1 ± 0.8
Symptom subscore (out of 2)	1.7 ± 0.5
Label subscore (out of 5)	4.5 ± 1

Data are *n* (%) or mean ± SD unless otherwise noted. *Length of hospitalization and A1C at diagnosis were missing for one patient diagnosed at another center. †When A1C was not available at the time of quiz administration, it was a telehealth visit.

the participants, while 19.5% were Non-Hispanic Black, and 4.9% were Hispanic. All patients were hospitalized at the time of diagnosis and spent an average of 2.7 ± 0.9 days as inpatients, during which time they met with the inpatient dietitian one time for a 1- to 2-hour education session. The average A1C at the time of type 1 diabetes diagnosis was 11.8 ± 2.2%.

Nutrition Assessment and Scores

The new-onset nutrition assessment was administered at the first or second outpatient diabetes clinic visit after the diagnosis of type 1 diabetes, which was a mean of 46.9 ± 28.6 days after the inpatient hospitalization. At the time the new-onset assessment was administered, the average A1C was 8.7 ± 1.6%, and 51.2% of participants were using CGM.

The nutrition assessment was completed by the participant and caregiver together (26.8%), the participant only (14.6%), or the caregiver only (58.5%). The average length of time it took to complete and review the nutrition assessment was 22.2 ± 6.8 minutes (range 10–45 minutes). The nutrition assessment was completed in person at 87.8% of visits, and 12.2% were completed via telemedicine during the COVID-19 pandemic (Table 1).

The overall average quiz score was 13.4 ± 3.1 points out of a maximum of 16 points. Participants scored an average of 4.1 ± 1.4 points out of 5 points on the "Insulin" section, 3.1 ± 0.8 points out of 4 points on the "Nutrition" section, 4.5 ± 1.0 points out of 5 points on the "Using a Nutrition Facts Label" section, and 1.7 ± 0.5 points out of 2 points on the "Symptoms and Complications" section.

Associations With Clinical Characteristics

There was a significant difference in quiz score by insurance type; participants with commercial insurance scored higher on average than those with public insurance (14.5 vs. 8.0, $P < 0.0001$) (Figure 1*A*). As shown in Figure *1B*, participants with commercial insurance also scored significantly higher on each component of the assessment. In unadjusted analysis, there were no differences in quiz score by participant age, sex, ethnicity, presence of diabetic ketoacidosis at diabetes onset, duration of diabetes, type of visit (in person or virtual), use of CGM, or who completed the quiz (caregiver, patient, or caregiver and patient together). Black participants had an unadjusted mean score lower than non-Black participants (10.3 vs. 14.2, $P = 0.0009$). However, a logistic regression that modeled the odds of passing the quiz (≥75% answered correctly) and controlled for age, sex, insurance type, race, and CGM use was computed and showed no statistically significant racial differences in odds of passing the quiz. In this logistic regression model, commercial insurance remained a predictor of passing the quiz (Table 2).

Discussion

ISPAD recommends the provision of nutrition therapy for all children and adolescents with diabetes that is introduced at the onset of type 1 diabetes and maintained with the guidance of a specialist pediatric dietitian (4). Diabetes-related nutrition education is often

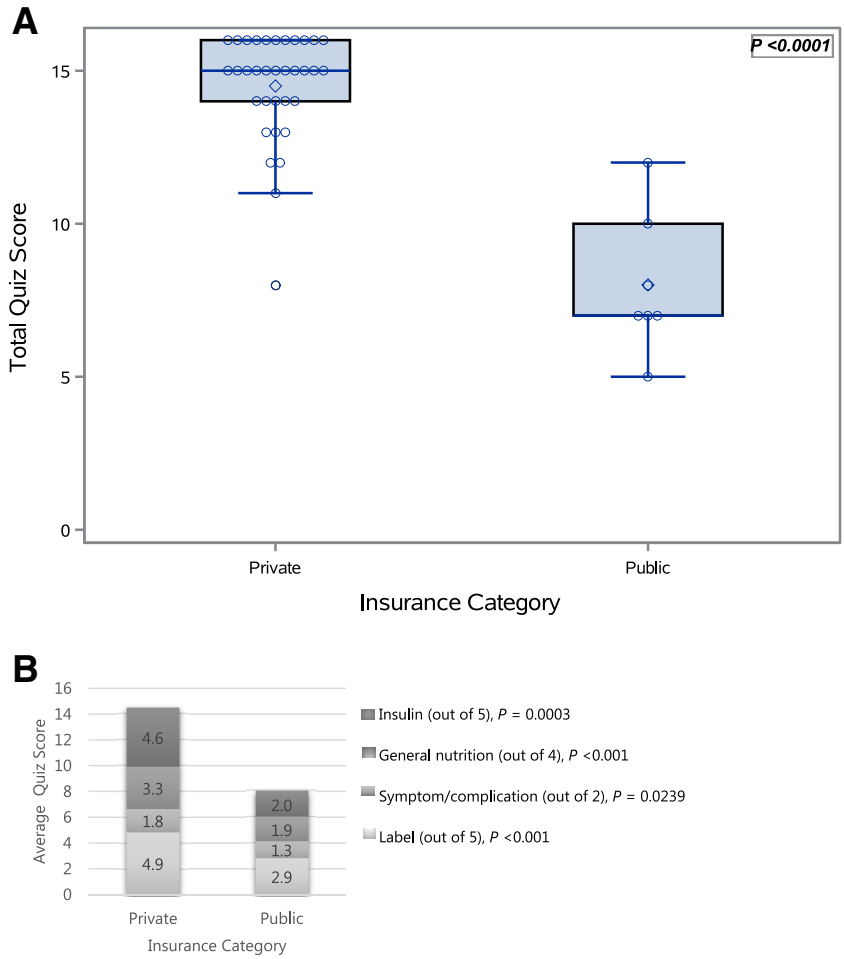

FIGURE 1 Quiz scores by insurance category (*A*) and quiz subset scores by insurance category (*B*). In *A*, the top and bottom of the boxes represent the interquartile range, the line within each box is the median, and the diamonds are the means.

standardized by site, with limited consistency across sites, such that the focus of diabetes nutrition education varies widely (8). Furthermore, there is suboptimal utilization of dietitian services even when they are available. The most recent ISPAD guidelines suggest that further research in effective nutrition interventions would be helpful to improve diabetes care. In this study, we demonstrated that a brief, reliable, and interactive assessment for patients with new-onset diabetes and their caregivers can provide an opportunity for nutrition knowledge reinforcement soon after a new diagnosis of diabetes.

Although some patients were able to complete the assessment without difficulty, it helped to identify knowledge gaps in fundamental nutrition education and facilitated nutrition education sessions with the dietitian in the diabetes clinic. We found lower nutrition scores among patients with public insurance compared with those with commercial insurance, highlighting the connection between economic status and insurance coverage and social determinants of health. Prior research has suggested that socioeconomic position contributes to health inequities in youth with type 1 diabetes (15,16), and a recent study by Sutherland et al. (17) showed that lower socioeconomic profiles were associated with worse glycemic control in youth with type 1 diabetes. Thus, our study further highlights the need for nutrition support in both inpatient and outpatient settings, particularly for patients with public insurance.

With the increasing use of telemedicine for diabetes care during the COVID-19 pandemic (18), we also looked at assessment scores between virtual and in-person visits. There was no difference in average assessment score for patients completing the quiz via telemedicine as part of a virtual visit or at in-person visits. Because telemedicine may be a part of the future of diabetes care, including nutrition education, it is reassuring that diabetes care can be delivered effectively on a virtual platform.

TABLE 2 Logistic Regression Model of Odds of Scoring ≥75% Correct on Nutrition Quiz

Variable	Unadjusted		Adjusted	
	Odds Ratio (95% CI)	*P*	Odds Ratio (95% CI)	*P*
Age at visit, years	1.05 (0.85–1.29)	0.66	1.09 (0.77–1.54)	0.62
Female sex (Ref: male)	1.23 (0.25–6.02)	0.80	2.36 (0.16–35.67)	0.54
Race non-Hispanic Black (Ref: White)	0.14 (0.02–0.78)	**0.025***	0.36 (0.02–7.43)	0.51
Medicaid insurance (Ref: commercial insurance)	0.01 (<0.001–0.13)	**0.0005†**	0.01 (<0.001–0.20)	**0.0018‡**
Uses CGM	0.5 (0.10–2.44)	0.39		
Duration of diabetes, days	0.99 (0.96–1.01)	0.25		
Length of hospital stay, days	0.51 (0.21–1.25)	0.14		

*P <0.05. †P <0.001. ‡P <0.01. Ref, reference category.

From a clinical and educational perspective, the dietitians administering the assessment often found it helpful to review each question with families, as this practice provided opportunities for clarifications based on verbal and nonverbal cues from the family. For families with limited literacy, reading the questions out loud may have aided in their understanding of the nutrition questions and some medical terminology. In particular, for the food label section, sometimes families did not know how to calculate total carbohydrates if they were not directly listed on the label. This was applicable in the fourth and fifth questions of the nutrition label section, where foods (apple and peanut butter) were added to the food in the label (crackers). This discussion allowed the dietitian to demonstrate the use of online resources (e.g., online food databases and phone apps) when no food label was available. Incorrect answers provided the dietitian with an immediate opportunity to reinforce fundamental diabetes nutrition and management education, thereby preventing long-term knowledge deficits that could affect overall diabetes care and outcomes. Incorrect answers also guided the dietitian in selecting focus points for the visit.

Although the average questionnaire completion and discussion time was 22 minutes, some nutrition visits were shorter and others longer (up to 45 minutes), based on the educational needs of the patient and/or caregiver, making completion of the assessment feasible during the first follow-up diabetes visit. Future research may consider shorter questionnaires as long as key nutrition and carbohydrate counting topics are reviewed.

This study has limitations. Although the cohort was diverse, the study population was small, and findings may not be generalizable to other populations. The survey was brief and feasible to implement but only addressed a few key nutrition topics rather than all the material covered during a diabetes nutrition education session. Because of the COVID-19 pandemic, some patients completed the nutrition surveys via telehealth, but this was a small sample; thus, it is difficult to draw conclusions from this group.

Conclusion

We developed, implemented, and validated a brief nutrition education assessment for recently diagnosed patients with type 1 diabetes that was feasible to integrate in a busy diabetes clinic. By using a standard assessment for newly diagnosed patients, dietitians and clinicians can more readily identify knowledge gaps and opportunities for point-of-care education. The diabetes team should provide additional educational support for families with public insurance, both at the time of diagnosis and thereafter. Future multicenter trials can further validate this nutrition questionnaire in other populations and practices.

DUALITY OF INTEREST

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

AUTHOR CONTRIBUTIONS

S.S., M.T., M.S., and R.M.W. performed the research and collected the data. S.S., M.T., Y.A., and R.M.W. wrote the manuscript. M.T., M.S., and R.M.W. designed the research study. E.B. and R.M.W. analyzed the data. All authors read and approved the final manuscript. R.M.W. 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 the accuracy of the data analysis.

PRIOR PRESENTATION

This work was previously presented in abstract form at the American Diabetes Association's virtual 81st Scientific Sessions, 25–29 June 2021.

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