HHS Public Access

Author manuscript

Diabet Med. Author manuscript; available in PMC 2016 September 01.

Published in final edited form as:

Diabet Med. 2015 September ; 32(9): 1232–1238. doi:10.1111/dme.12682.

Validation of a contemporary adherence measure for children with Type 1 diabetes: the Diabetes Management Questionnaire

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Abstract

Aims—To evaluate the psychometric properties of the Diabetes Management Questionnaire, a brief, self-report measure of adherence to contemporary diabetes management for young people with Type 1 diabetes and their caregivers.

Methods—A total of 273 parent-child dyads completed parallel versions of the Diabetes Management Questionnaire. Eligible children (aged 8–18 years) had Type 1 diabetes for ≥1 year. A multidisciplinary team designed the Diabetes Management Questionnaire as a brief, self-administered measure of adherence to Type 1 diabetes management over the preceding month; higher scores reflect greater adherence. Psychometrics were evaluated for the entire sample and according to age of the child.

Results—The children (49% female) had a mean ± SD (range) age 13.3 ± 2.9 (8–18) years and their mean ± SD HbA1c was 71 ± 15 mmol/mol (8.6 ± 1.4%). Internal consistency was good for parents (α = 0.83) and children (a = 0.79). Test-retest reliability was excellent for parents (intraclass correlation coefficient =0.83) and good for children (intraclass correlation coefficient = 0.65). Parent and child scores had moderate agreement (intraclass correlation coefficient = 0.54). Diabetes Management Questionnaire scores were inversely associated with HbA1c (parents: $r = -0.41$, $P < 0.0001$; children: $r = -0.27$, $P < 0.0001$). Psychometrics were stronger in the children aged ≥13 years compared with those aged < 13 years, but were acceptable in both age groups. Mean ± SD Diabetes Management Questionnaire scores were higher among children who were receiving insulin pump therapy ($n = 181$) than in children receiving multiple daily injections ($n = 92$) according to parent (75.9 ± 11.8 vs. 70.5 ± 15.5; P = 0.004) and child report (72.2 ± 12.1 vs. 67.6 ± 13.9; $P = 0.006$).

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Competing interests
None declared.

Supporting Information
Additional Supporting Information may be found in the online version of this article:

Appendix S1 The Diabetes Management Questionnaire.

Conclusions—The Diabetes Management Questionnaire is a brief, valid self-report measure of adherence to contemporary diabetes self-management for people aged 8–18 years who are receiving either multiple daily injections or insulin pump therapy.

Introduction

Daily management of Type 1 diabetes requires balancing insulin, diet and exercise, guided by frequent monitoring of blood glucose. The introduction of insulin analogues and greater use of insulin pump therapy have fostered contemporary approaches to physiological insulin replacement. Despite pharmaceutical and technological advances, there are significant gaps between recommended and attained treatment outcomes, most notably glycaemic control [1,2], as a result of challenges associated with adhering to the recommended diabetes treatment programme. Numerous factors, including knowledge and perceived burden, may affect adherence to the unremitting task of managing Type 1 diabetes [3,4].

Greater diabetes adherence has been consistently associated with lower HbA1c levels in young people with Type 1 diabetes [5,6]. Measures of adherence to diabetes-related tasks can inform the relationship between prescribed diabetes treatment regimens and observed health outcomes. Validated adherence measures for Type 1 diabetes include direct observation, 24-h recalls [7,8], semi-structured interviews [9–11], patient self-report questionnaires [12–14] and technological methods (e.g. blood glucose meter data) [15,16]. New measures are frequently informed by established methods, but aim to provide a unique benefit over existing measures, for example, ease of administration, brevity and closer alignment with modern therapies [17,18]. Typically, adherence measures that are the most comprehensive and patient-specific tend to be the most resource-intensive and, thus, the least practical for application across diverse clinical and research settings. Additional considerations when choosing an adherence measure include the temporality of assessment (e.g. days to months), adaptation to particular treatment approaches (e.g. insulin pump therapy) and validation in young patient populations.

Recently, diabetes adherence measures have been adapted to modern treatment approaches [14,17–20]; however, most of these measures were validated in people aged ≥ 10 years. Recent data suggest a significant rise in the incidence of Type 1 diabetes in children aged <10 years, and especially children aged < 5 years [21]. Increasingly, parents are sharing the responsibility of diabetes-related tasks, such as blood glucose monitoring and insulin self-administration, with younger children with Type 1 diabetes [22]. We developed the Diabetes Management Questionnaire (DMQ) to provide a brief, selfreport measure of adherence to contemporary diabetes selfmanagement for young people with Type 1 diabetes, including those as young as 8 years, that can be easily administered in both clinical and research settings. We evaluated the psycho-metric properties of the newly developed DMQ in children aged 8–18 years old and their parents.

Participants and methods

Study population

The survey was administered to children aged 8–18 years with Type 1 diabetes of at least 1 year duration and their parents (where ‘parent’ refers to a parent or legal guardian). All the children received ≥ 0.5 units/kg of insulin daily. Children with Type 1 diabetes and their parents were recruited during routine clinic visits to an urban, paediatric diabetes centre in Boston, MA. If a family enrolled multiple siblings with Type 1 diabetes, data from the child with the longest diabetes duration were used. If two parents attended the appointment, the parent reporting primary responsibility for day-to-day diabetes care was enrolled.

Informed consent was obtained from the parents and young people aged ≥ 18 years, and assent was obtained from children aged < 18 years. The parents and children received compensation for their participation. The local institutional review board approved the study protocol.

Questionnaire development

The DMQ (Appendix S1) was created by a multi-disciplinary team consisting of paediatric endocrinologists, paediatric diabetes nurses, certified diabetes educators, registered dietitians, behavioural scientists and nutrition scientists. It was designed for administration to people as young as 8 years and includes parent-reported and child-reported versions to assess adherence to the child’s treatment regimen. Survey items were informed by previous work in the field, including the Self-Care Inventory [13,23] and Diabetes Self-Management Profile [10,17,18,20].

The DMQ assesses adherence to diabetes management tasks over the last month to coincide with the measurement of HbA1c, reflecting average glucose levels over the previous 8–12 weeks, with greater weighting towards glucose levels over the past month. Survey content includes items related to insulin management, particularly to physical activity, diet, hyperglycaemia, hypoglycaemia and blood glucose monitoring. Items are worded so that they are applicable to both injection-based therapy and insulin pump therapy. Response options on the 20-item survey are based on a five-point Likert scale ranging from ‘almost never’ to ‘almost always’.

Administration and scoring

The children and their parents independently completed parallel versions of the DMQ. All participants required 5–10 min to complete the DMQ. To assess test-retest reliability, the DMQ was mailed to participants 2 weeks after the initial survey completion, with the goal of completing the retest within 6 weeks of the initial assessment.

Each item was scored from 0 to 4, with higher scores reflecting greater adherence to the diabetes-related task. Six of the 20 items were reverse-scored. The mean of all completed items was calculated and then multiplied by 25 to normalize to a 0–100 scale to facilitate interpretation. Higher total DMQ scores defined greater adherence to diabetes management.

Additional measures

Demographic characteristics were obtained from parent selfreport. Details on diabetes history and current treatment regimen were abstracted from electronic health records. Blood glucose monitoring frequency was assessed by medical chart review, using either meter download or patient report, and physician report of insulin omission was abstracted from the medical record to assess the convergent validity of the DMQ. HbA1c was assayed using high-performance liquid chromatography [Tosoh 2.2 device; Tosoh Corp., San Francisco, CA, USA; reference range 20–42 mmol/mol (4.0–6.0%)].

Statistical analyses

Descriptive analyses are presented as means ± SD or percentages. DMQ psychometrics were assessed for the parent and child surveys and additionally stratified according to age of the child (< 13 vs. ≥ 13 years) to assess the psychometrics for the pre-adolescent and adolescent participants and their parents. As a secondary analysis, psychometrics of the parent DMQ and child DMQ were evaluated in very young children aged < 10 years.

Cronbach's α coefficient was used to assess internal consistency. The intraclass correlation coefficient (95% CI) was used to assess test-retest reliability at 6 weeks and parent-child agreement. Pearson correlations were used to assess the associations between DMQ scores and HbA1c (criterion validity) and DMQ scores and blood glucose monitoring frequency (convergent validity). Differences in mean DMQ scores between the parents and children were compared by paired (within family) and unpaired t-tests (between child age groups), and differences according to the presence or absence of insulin omission were compared using an unpaired *t*-test.

Correlations and paired *t*-tests were used to assess the associations between demographic and clinical characteristics with both DMQ scores and HbA1c. All analyses used the initial DMQ scores with the exception of those comparing initial and re-test responses. Non-parametric statistics were used in the secondary analysis of children aged < 10 years, owing to the small sample size and non-normal distribution. Analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC, USA). *P* values < 0.05 were taken to indicate statistical significance.

Results

A convenience sample of 302 children, representing 291 families, participated in the study. For families that enrolled multiple siblings, data from the child with the longest diabetes duration were used. Both the youth and parent completed the DMQ in 94% (n = 273) of the resulting 291 parent-child dyads. There was no difference ($P > 0.05$ for all comparisons) in mean age, diabetes duration or HbA1c levels for those completing and not completing the DMQ. Sample characteristics are summarized in Table 1. The sample was 90% white, which was representative of the clinic population from which it was drawn. The mother completed the parent DMQ for most (85%) children. Most parents had more than a high school education (89%), lived with their spouse or partner (84%) and reported having private

insurance (88%). Socio-economic characteristics did not differ between the younger (8–13 years) and older (13–18 years) children with Type 1 diabetes.

The children with Type 1 diabetes aged < 13 years had significantly lower HbA1c levels than those aged ≥ 13 years [66.6 ± 11.8 mmol/mol (8.2 ± 1.1%) vs. 73.7 ± 17.0 mmol/mol (8.9 ± 1.6%); $P < 0.0001$]. Overall, 27% of the children met age-specific HbA1c targets established by the American Diabetes Association (ADA) and a significantly higher percentage of the younger children achieved ADA HbA1c targets compared with the older ones (42 vs. 14%; $P < 0.0001$).

Internal consistency

The psychometric properties of the DMQ are summarized in Table 2. The internal consistency (Cronbach's α) for the DMQ was 0.83 for the parents and 0.79 for the children. Among the children, Cronbach's α was higher for the older (0.82) than for the younger ones (0.70). Item-to-total correlations were all positive; however, one of the reversed-scored questions ('.. .give all of an insulin dose after you finished eating?') had a low item-to-total correlation of <0.10. This item was retained, however, given its clinical relevance.

Test-retest reliability

Follow-up surveys were returned within 6 weeks by 73% ($n = 194$) of parents and children and were included in the test-retest analysis. The test-retest intraclass correlation coefficient between the DMQ scores for the parents was 0.83 and for the children was 0.65 (Table 2). In separate analyses by age group, the test-retest intraclass correlation coefficient for the younger of the children with diabetes was low (0.49), whereas the intraclass correlation coefficients for the older of the children and for the parents of younger and older children with diabetes were acceptable (0.73, 0.76 and 0.85, respectively).

Validity

Predictive validity was assessed by associations with HbA1c. The DMQ scores of the parents ($r = –0.41$, $P < 0.0001$) and children ($r = −0.27$, $P < 0.0001$) were significantly correlated with the HbA1c levels of the children. Furthermore, the mean ± SD DMQ score for parents of children achieving ADA HbA1c goals was higher than the mean DMQ scores for parents of young people not achieving the HbA1c goals (80.0 ± 10.7 vs. 71.9 ± 13.6; $P < 0.0001$). Similarly, the mean DMQ score for the children achieving age-specific ADA HbA1c goals was significantly higher than the mean DMQ scores for the children not achieving HbA1c goals (73.2 ± 12.7 vs. 69.7 ± 12.9; $P = 0.048$). Among the chil dren aged ≥ 13 years, the correlations of parent and child DMQ scores with HbA1c were −0.36 ($P < 0.0001$) and −0.39 ($P < 0.0001$), respectively. Among children aged < 13 years, parent DMQ scores were similarly correlated with the child's HbA1c level ($r = –0.36$, $P < 0.0001$); however, DMQ scores for children aged < 13 years were not associated with HbA1c ($r = 0.08$, $P = 0.40$).

Convergent validity was assessed according to associations with blood glucose monitoring frequency and provider report of insulin omission. The DMQ scores of the parents ($r = 0.52$, $P < 0.0001$) and young people ($r = 0.36$, $P < 0.0001$) were significantly correlated with

blood glucose monitoring frequency. Among the older age group of children with diabetes, the correlations of the child and parent DMQ scores with blood glucose monitoring frequency were 0.44 ($P < 0.0001$) and 0.49 ($P < 0.0001$), respectively. Among children aged <13 years, parent DMQ scores were significantly correlated with blood glucose monitoring frequency ($r = 0.36$, $P < 0.0001$), but child DMQ scores were not ($r = 0.09$, $P = 0.3$). DMQ scores were lower for parents (72.6 ± 14.0 vs. 76.9 ± 11.7, $P = 0.01$) and children (68.4 ± 12.2 vs. 75.0 ± 13.1; $P < 0.0001$) whose providers reported insulin omission compared with those without missed insulin doses.

Parent-child agreement

Overall, the mean DMQ score of the parents was higher than that of the children (74.1 ± 13.4 vs. 70.6 ± 12.9; $P = 0.003$). Children aged < 13 years old had significantly lower mean DMQ scores compared with their parents (73.7 ± 11.5 vs. 79.0 ± 10.5; $P = 0.0002$), but there was no difference in mean DMQ score between children aged ≥ 13 years and their parents (68.0 ± 13.5 vs. 69.9 ± 14.1; $P = 0.3$). The intraclass correlation coefficient for the DMQ scores of the parents and children was 0.54. The intraclass correlation coefficient for children aged ≥ 13 years and their parents' DMQ scores was 0.63, while the intraclass correlation coefficient for children aged < 13 years and their parents' DMQ scores was 0.30.

Associations with demographic and diabetes characteristics

Parent DMQ scores (69.9 ± 14.1 vs. 79.0 ± 10.5; $P < .0001$) and youth DMQ scores (68.0 ± 13.4 vs. 73.7 ± 11.5; $P = 0.0003$) were lower for the older than for the younger age group. Parent DMQ scores were inversely correlated with their child's age ($r = –0.40$, $P < 0.0001$) and diabetes duration ($r = –0.29$, $P < 0.0001$). Similarly, the child's DMQ scores were inversely correlated with the child's age ($r = –0.22$, $P = 0.0002$) and diabetes duration ($r = –0.17$, $P = 0.003$). Parent DMQ scores were higher in households with two caregivers than in those with one caregiver (75.1 ± 12.7 vs. 68.7 ± 15.2; $P = 0.003$). There were no differences in parent or child DMQ scores according to the parent's level of education or insurance status (e.g. private vs. public insurance). DMQ scores of the children but not of the parents were higher among non-Hispanic white children than in those belonging to racial and ethnic minority groups (71.3 ± 12.8 vs. 65.8 ± 12.5; $P = 0.04$).

Table 1 shows the associations between demographic and clinical characteristics of young people according to insulin regimen. Parents of children who were receiving insulin pump therapy had higher DMQ scores than parents of children receiving multiple daily injections (75.9 ± 11.8 vs. 70.5 ± 15.5; $P = 0.004$). Similarly, children receiving insulin pump therapy had higher DMQ scores than those receiving multiple daily injections (72.2 ± 12.1 vs. 67.6 ± 13.9; $P = 0.006$). The young people receiving pump therapy had lower HbA1c values [66.7 ± 11.3 mmol/mol (8.3 ± 1.0%) vs. 77.9 ± 18.8 mmol/mol (9.3 ± 1.7%); $P < .0001$] and greater daily blood glucose monitoring frequency (5.8 ± 2.1 vs. 4.4 ± 2.1 checks; $P < 0.0001$) compared with children using multiple daily injections.

Diabetes Management Questionnaire psychometrics in children aged < 10 years

A total of 45 children aged < 10 years and their parents completed the DMQ. The internal consistency for the DMQ was 0.69 for parents of children aged < 10 years and 0.73 for

children aged < 10 years. For these children, the DMQ scores of the parent (r = –0.18, *P* = 0.2) and child (r = –0.02, *P* = 0.9) were not significantly correlated with the child's HbA1c. For children aged < 10 years, the DMQ scores of the parent (r = 0.39, *P* = 0.009), but not the child (r = 0.20, *P* = 0.2), were significantly correlated with blood glucose monitoring frequency. The intraclass correlation coefficient for parents' and children's DMQ scores was 0.35. Notably, parent (*r* = –0.28, *P* = 0.02), but not child (*r* = –0.03, *P* = 0.8) DMQ scores were correlated with the child's HbA1c for all children aged < 11 years, which included an additional 26 families of children aged 10 to < 11 years.

Discussion

The DMQ is a brief, self-administered measure of adherence to diabetes management tasks for children with Type 1 diabetes and their parents. The DMQ was designed for children with Type 1 diabetes as young as 8 years old, treated with either multiple daily injections or insulin pump therapy. A multidisciplinary team with experience in all aspects of paediatric diabetes management, behavioural research and survey design developed the DMQ, which was informed by existing measures of diabetes adherence. The self-administered 20-item questionnaire requires only 5–10 min to complete. It was designed as a measure of diabetes adherence for use in clinical and research settings.

The DMQ measures adherence to insulin administration, blood glucose monitoring, dietary behaviours and exercise. The DMQ was found to have adequate internal consistency. Cronbach's a coefficient was good for the parents (0.83) and children (0.79). Test-retest reliability at 6 weeks was also good for the parents (0.83) and acceptable for the young people (0.65). Parent-child agreement was acceptable. Psychometric properties performed less well in children aged < 13 years, as might be expected given the complexities of diabetes management and reliance upon parent involvement and adult supervision for diabetes care in school-age children [24,25]. The reading level of the DMQ was 7.5 (Fleisch–Kincaid grade level, Microsoft Corp., Redmond, WA, USA). As such, it is likely that comprehension of the DMQ items was superior in the older than in the younger children with diabetes.

Content validity was based on input from a multidisciplinary team, in addition to reference to existing measures of diabetes adherence. Predictive validity was based on a significant, inverse association between parent and child DMQ scores with the child's HbA1c level. The effect size (–0.27 to –0.41) was consistent with published measures of diabetes adherence [5,20]. The frequency of blood glucose monitoring, a central component of intensive diabetes therapy, may serve as a simple, albeit limited, measure of adherence [6,15]. Convergent validity was confirmed by significant associations with blood glucose monitoring frequency and report of insulin omission. Among parents and children, more frequent blood glucose monitoring and absence of missed insulin doses were associated with higher DMQ scores.

The DMQ scores of the parents and children were inversely correlated with the child's age and diabetes duration. This is consistent with previous studies demonstrating lower adherence in older children and in those with longer diabetes duration [12,14,20]. Children

using insulin pump therapy and their parents reported greater adherence to diabetes management compared with children using multiple daily injections and their parents. Similarly, blood glucose monitoring frequency was higher in children using pump therapy than in those using multiple daily injections. Adherence to diabetes self-management in children treated with insulin pump therapy probably explains the lower mean HbA1c in this group compared with children treated with multiple daily injections.

Interestingly, both the parent and child DMQ scores were higher in children aged < 13 years compared with their respective scores for children aged ≥ 13 years. For those aged < 13 years, the parent DMQ demonstrated reliability and external validity; however, the child DMQ did not demonstrate adequate psychometric properties. As such, for children aged < 13 years, the parent DMQ should be used to assess adherence to diabetes management. These findings may be explained by greater parental involvement in daily diabetes tasks for pre-adolescent children, and and by developmental limitations in young children's ability to recall diabetes management behaviours during the preceding month. More limited comprehension of survey items may also be a reason for the poorer performance of the child DMQ in this age group. Future adherence measures may benefit from cognitive interviews of pre-adolescent children during survey development to ensure their understanding of all survey items. Finally, the cross-sectional analysis precludes assessment of change in self-reported adherence over time, which may provide additional support for the use of this measure across all ages.

In a secondary analysis, the psychometrics of the parent DMQ and child DMQ were evaluated in a more restricted sample of children aged < 10 years. The parent DMQ demonstrated reasonable reliability and validity; the non-significant association with HbA1c may relate to the small sample size as this relationship was significant in children aged < 11 years, which included an additional 26 participants. Future studies in larger samples of parents of children with Type 1 diabetes aged < 10 years will improve our understanding of the performance of this measure in young children. For children < 10 years old, the child DMQ demonstrated modest reliability and no significant measure of validity. We presume this relates to the better understanding of daily diabetes management of parents who are primarily responsible for diabetes tasks in this age group; however, we cannot exclude other factors, including comprehension of survey items and recall ability. Similar to findings in older preadolescent children, the parent DMQ is a reliable measure to assess adherence to diabetes management in children aged < 10 years.

Families who reported living in households with two adult caregivers had higher DMQ scores than parents living in single-parent households. This finding may support previous work that found positive associations between family support, diabetes adherence and glycaemic control [14,25–27]; however, neither parent nor child DMQ scores were associated with other socio-economic measures, such as parent education or child's insurance status. Children from minority ethnic groups had modestly lower DMQ scores compared with non-Hispanic white children, but this association was not evident in parent DMQ scores. Future studies in more diverse populations of children with Type 1 diabetes may expand and clarify these findings.

In summary, the DMQ was found to be reliable and valid in a large sample of contemporary children with Type 1 diabetes, aged 8–18 years, and their parents. Among young people, for those aged < 13 years the measure demonstrated consistency; for those aged ≥ 13 years, the measure demonstrated both consistency and validity. The DMQ offers an opportunity for self-assessed adherence to diverse diabetes management tasks in children aged 8–18 years old. The child DMQ is a relevant self-report measure for children ≥ 13 years as there are greater adherence issues among adolescents than among younger children. The parent DMQ can assess self-reported adherence to diabetes management in children aged < 13 years. Prospective evaluation of this survey in school-age children and adolescents will help confirm its utility in assessing change in adherence over time, especially for younger children. Future investigations of this measure in varied geographic areas, diverse patient samples and in longitudinal assessments will inform the generalizability of the present findings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Portions of this manuscript were presented at the 70th Scientific Sessions of the ADA (2010). We are grateful to all of the families who participated in this study.

Funding sources

This research was supported by the intramural research programme of the National Institutes of Health, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, contract number HHSN26720070 3434C and the Joslin Diabetes Center's Diabetes and Endocrinology Research Center (NIH P30DK036836).

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What's new?

- Adherence to diabetes self-management is associated with better glycaemic control in young people with Type 1 diabetes. Young people with Type 1 diabetes and their parents often share in diabetes-related tasks.
- Most available measures to assess diabetes adherence have been validated in adolescents and many require significant time to administer. The Diabetes Management Questionnaire (DMQ) was developed to provide clinicians and clinical investigators with an efficient, easy-to-use and self-administered tool to assess adherence to diabetes self-management in people with Type 1 diabetes aged 8–18 years and their parents. The DMQ was validated in children treated using multiple daily injections or insulin pump therapy.

Table 1

Characteristics of the children with Type 1 diabetes included in the study, overall and stratified by insulin regimen

	All ***N*** **= 273**	**Insulin pump** ***n*** **= 181**	**Multiple daily injections** ***n*** **= 92**	***P*** *
Age (years), mean ± sd (range)	13.3 ± 2.9 (8.1–18.2)	13.2 ± 2.8 (8.1–18.2)	13.7 ± 3.0 (8.2–18.0)	0.2
Sex (female), %	49	48	50	0.8
BMI (z-score), mean ± sd (range)	0.7 ± 0.8 (−2.0 to 2.4)	0.7 ± 0.8 (−2.0 to 2.4)	0.7 ± 0.8 (−1.7 to 2.3)	0.7
Race (white), %	90	95	80	0.0001
Parent education level, %				0.005
High school or lower	10	9	15	
College	69	66	72	
Graduate school	21	25	13	
Insurance (private), %	88	94	77	0.0002
Family structure (two-parent), %	84	89	72	0.0003
Diabetes duration (years), mean ± sd (range)	6.5 ± 3.4 (1.0–15.5)	6.6 ± 3.2 (1.3–14.9)	6.3 ± 3.6 (1.0–15.5)	0.4
HbA1c (mmol/mol), mean ± sd (range)	71 ± 15 (42–140)	67 ± 11 (42–107)	78 ± 19 (49–140)	<0.0001
HbA1c (%), mean ± sd (range)	8.6 ± 1.4 (6.0–15.0)	8.3 ± 1.0 (6.0–11.9)	9.3 ± 1.7 (6.6–15.0)	<0.0001
Blood glucose monitoring (checks/day), mean ± sd (range)	5.3 ± 2.2 (0–10)	5.8 ± 2.1 (0–10)	4.4 ± 2.1 (0–10)	<0.0001
Insulin dose (units/kg/day), mean ± sd (range)	0.9 ± 0.3 (0.5–2.8)	0.9 ± 0.2 (0.5–1.7)	1.0 ± 0.3 (0.5–2.8)	<0.0001
DMQ score: child, mean ± sd (range)	70.6 ± 12.9 (32.5–100.0)	72.2 ± 12.1 (41.3–100.0)	67.6 ± 13.9 (32.5–92.5)	0.006
DMQ score: parent, mean ± sd (range)	74.1 ± 13.4 (16.3–98.8)	75.9 ± 11.8 (37.5–97.5)	70.5 ± 15.5 (16.3–98.8)	0.004

DMQ, Diabetes Management Questionnaire.

*Differences between children with diabetes using pump vs. those on an injection-based insulin regimen.

Table 2

Diabetes Management Questionnaire scores and psychometrics for children with Type 1 diabetes and their parents, stratified by child age

	All participants	Age <13 years	Age ≥13 years	*P* *
Children with Type 1 diabetes				
Initial score (*n* = 273), mean sd (range)	70.6 ± 12.9 (32.5–100.0)	73.7. ± 11.5 (42.5–92.5)	68.0 ± 13.5 (32.5–100.0)	0.0003
Internal consistency, α	0.79	0.70	0.82	
Re-test score (*n* = 255), mean sd (range)	74.2 ± 13.7 (25.0–98.8)	77.9 ± 11.8 (41.3–98.8)	71.1 ± 14.4 (25.0–98.8)	<0.0001
Intraclass correlation coefficient**	0.65	0.49	0.73	
Parents				
Initial score (*n* = 273), mean ± sd (range)	74.1 ± 13.4 (16.3–98.8)	79.0 ± 10.5 (42.5–98.8)	69.9 ± 14.1 (16.3–96.3)	<0.0001
Internal consistency, α	0.83	0.70	0.84	
Re-test score (*n* = 254), mean ± sd (range)	75.3 ± 12.9 (31.3–98.7)	80.2 ± 10.4 (52.5–98.7)	70.9 ± 13.2 (31.3–95.0)	<0.0001
Intraclass correlation coefficient**	0.83	0.76	0.85	

* Difference in Diabetes Management Questionnaire (DMQ) scores by child age.

** Intraclass correlation coefficient=intraclass correlation coefficient between initial DMQ score and re-test DMQ score.