

Predictors of Diabetes-related Quality of Life after Transitioning to the Insulin Pump

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Objective To examine family and individual psychosocial, medical, and demographic factors associated with improved diabetes-related quality of life (QOL) after transitioning to the insulin pump among youth with type 1 diabetes. **Methods** Fifty-three parent-child dyads completed questionnaires on four occasions prior to and following this medical regimen change, assessing QOL, family environment, depressive and anxiety symptoms, and medical and demographic information. Trajectories of change in QOL were analyzed using multilevel modeling. **Results** Psychosocial, medical, and demographic characteristics were associated with QOL prior to pump-start. Elements of children's QOL significantly improved after the transition, and improvement was predicted by psychosocial, medical, and demographic characteristics. **Conclusions** Results indicate that individual and contextual factors may play a role in QOL as children transition to the insulin pump. Findings may guide efforts to support families through this challenging time and potentially inform candidacy for transition to the pump.

Key words children; diabetes; quality of life.

Type 1 diabetes has been associated with poor health-related quality of life (QOL) in children and adolescents (Cameron, Northam, Ambler, & Daneman, 2007). Health-related QOL is a measure of an individual's well-being with respect to the role health plays in his/her daily life. It may encompass several elements, including satisfaction with the current status and treatment of the illness, the impact of the illness on everyday functioning, and how much one worries about or is bothered by his/her illness (Ingersoll & Marrero, 1991). A child's diabetes-related QOL is important, not only to overall psychological adaptation, but also to health status, as it is associated with diabetes management, including medical regimen adherence, metabolic control (as measured by HbA1C), and risk for long-term complications (Cameron et al., 2007; Guttman-Bauman, Flaherty, Strugger, & McEvoy, 1998; Hoey et al., 2001). Substantial research has identified relationships between behavior, psychological adjustment, depression, anxiety, parenting, family environment, regimen adherence, and glycemic control

(Auslander, Anderson, Bubb, Jung, & Santiago, 1990; Cohen, Lumley, Naar-King, Partridge, & Cakan, 2004; Hanson, Henggeler, & Burghen, 1987; Lernmark, Persson, Fisher, & Rydelius, 1999), but studies have only begun to identify factors related specifically to children's health-related QOL (Graue, Wentzel-Larsen, Hanestad, & Søvik, 2005; Grey, Boland, Yu, Sullivan-Bolyai, & Tamborlane, 1998; Grey, Davidson, Boland, & Tamborlane, 2001; Valenzuela et al., 2006; Wiebe et al., 2005).

Individual psychosocial and family variables (e.g., family conflict, child behavior problems, and parental distress) have demonstrated links to youth's health-related QOL (Valenzuela et al., 2006). Consistent with a transactional family systems framework (Kazak, 1989), caring for a child with a chronic illness may impact the family environment (i.e., conflict, cohesion, and communication; Northam, Anderson, Adler, Werther, & Warne, 1996), which may in turn impact the child's well-being. General family conflict and cohesion, parental involvement, youth depressive and anxiety symptoms, and metabolic

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control consistently emerge as factors in children's diabetes-specific QOL (Graue et al., 2005; Grey et al., 1998, 2001; Valenzuela et al., 2006; Wiebe et al., 2005). Age may also be relevant to health-related QOL; older adolescents may report poorer diabetes-specific QOL than younger adolescents (Graue et al., 2005), although some studies find no differences (Valenzuela et al., 2006; Wiebe et al., 2005). Younger youth seem to rate family as more important to health-related QOL than friends, while the pattern is reversed for older youth (Wagner, Abbott, & Lett, 2004).

A child's diabetes regimen may be associated with health and health-related QOL as well (Boland, Grey, Oesterle, Frederickson, & Tamborlane, 1999). Results from the Diabetes Complications and Control Trial (DCCT) indicated that intensive regimens (i.e., ≥ 4 injections/day, continuous subcutaneous insulin infusion or CSII) may help delay or prevent the onset of complications (The Diabetes Control and Complications Trial Research Group, 1993), and such regimens are now being prescribed to an increasing number of children (Pickup & Keen, 2002). CSII, commonly known as the insulin pump, is one type of intensive regimen that likely allows for a more physiologically precise delivery of insulin and a more flexible lifestyle than other regimens (Hoogma et al., 2005). The pump has been associated with both medical and psychosocial benefits as compared to conventional or other intensive regimens, including better metabolic control and diabetes-related QOL, and lesser impact of diabetes on daily life (Cameron et al., 2007; Hoogma et al., 2005; Weissberg-Benchell, Antisdell-Lomaglio, & Seshdari, 2003). Examination of changes over time during the transition to an intensive regimen consistently demonstrate maintenance of or improvement in metabolic control and QOL, and a decreased risk for hypoglycemia after transitioning to the pump (Cogen, Henderson, Hansen, & Streisand, 2007; Fox, Buckloh, Smith, Wysocki, & Mauras, 2005; Juliusson, Graue, Wentzel-Larsen, & Søvik, 2006; McMahon et al., 2004). This pattern may be particularly salient for those with poorer control prior to pump initiation (Rodrigues, Reid, Ismail, & Amiel, 2005). Children may transition to the pump with the goal of obtaining these benefits, which they might expect will contribute to or improve their health-related QOL.

Previous studies have found that individual and family environment characteristics have links to children's health-related QOL (Grey et al., 1998; Valenzuela et al., 2006). Most comparisons of QOL between regimens have compared values before and after initiating pump use with *t*-tests or analyses of variance and have not considered

trajectories of change during the transition or factors contributing to the changes that were found (Cogen et al., 2007; Juliusson et al., 2006; McMahon et al., 2004), leaving much unknown about youths' and families' experiences over this period. This is potentially an important period for investigation of QOL, given the changes in daily management tasks and the lifestyle improvements individuals may hope for the insulin pump regimen to bring. This study attempts to fill gaps left by the existing research by examining within-person changes in QOL during the time of pump transition in order to identify common family, psychological, medical, and demographic factors that may contribute to improved health-related QOL during this period. This study draws on previous research that has identified the factors associated with diabetes-related health, general psychological well-being, and QOL, and examines them in relation to change in health-related QOL during a time of medical transition. Specifically, this study's hypotheses were (a) children's report of better health-related QOL prior to pump transition would be associated with less family conflict, more family cohesion, better psychosocial functioning, and better metabolic control; (b) children's health-related QOL would improve over the transition to the pump; and (c) the amount of change in children's health-related QOL would be predicted by less family conflict, more family cohesion, better psychosocial functioning, and poorer metabolic control. Analyses of associations between QOL and demographic variables and analyses of change in metabolic control were exploratory.

Methods

Participants

Participants included 53 dyads composed of a youth with type 1 diabetes (64% female) and one parent (89% mothers). Youths' ages ranged from 8 to 17 years with a mean age of 12.0 years ($SD = 2.4$), and the mean parent age was 40.5 years ($SD = 6.1$). Most of the participants lived in a home with two or more adults (86%), and the majority of parents were married or living with a partner (85%) and completed education beyond high school (89%). Most children were Caucasian (87%). Participants had a mean illness duration of 4.4 years ($SD = 3.3$) and a mean HbA1C level prior to pump-start of 7.5% ($SD = .87$). Approximately one-half (49%) were on a conventional regimen (2–3 injections/day) prior to transitioning to the pump, and 51% were on another intensive regimen (multiple daily injections, ≥ 4 injections/day). At the time of data collection, the standard practice of the diabetes clinic from which this sample was drawn was to primarily encourage pump therapy in those children with adequate

metabolic control and without major mental health concerns. When pump therapy was introduced in this clinic, families were considered for the regimen based on their indication of interest. In order to be considered for the pump, children must have been on a regimen with three injections/day and four BG checks/day for 3–6 months. When other intensive basal bolus regimens (i.e., Lantus) became available, the clinic requirement changed and children were required to be on basal bolus regimen for 3–6 months prior to beginning the pump. Children were not transitioned to the pump regimen based on HbA1C values, but rather were selected by the clinical team according to their interest and general demonstration of good regimen adherence. Eligibility requirements for this study included (a) age between 8 and 17 years, (b) illness duration of at least 1 year, (c) transition to the insulin pump planned, and (d) fluency in English.

Procedure

Participants were recruited from the diabetes clinics of a Mid-Atlantic urban children's hospital by sending letters to families of children who were recently transitioned to the insulin pump, and contacting them by telephone to explain the study and obtain consent and assent. Participants gave their consent for use of the baseline data that had been collected as part of the hospital's standard psychological screening prior to pump transition. At the time of study consent, parents and children were invited to complete questionnaires on three additional occasions, at 1, 6, and 12 months after initiating pump use. Child and parent participants were instructed to complete the questionnaires alone and to not discuss their responses with one another. The packet of questionnaires took ~30–45 min to complete, and dyads were given a \$5 gift card for their participation at each time-point. Additionally, medical records were reviewed to corroborate medical information. The study was approved by the institutional review board of the children's hospital at which it took place.

Measures

The Diabetes Quality of Life for Youths scale (DQOL-Y; Ingersoll & Marrero, 1991) measured child-report of health-related QOL. This 53-item questionnaire is a modified version of the measure used in the DCCT that asks respondents to rate their feelings about different aspects of their diabetes regimen. In this study, scores from the three subscales (Impact, Worries, and Satisfaction) and a Total QOL sum score were used. All scales are reverse-scored such that higher numbers indicate poorer QOL, and decreasing values indicate improvement. The DQOL-Y has been

shown to be reliable (Ingersoll & Marrero, 1991). In this sample, across the four administrations the internal consistency (α) for the Impact scale ranged from .68 to .86, Worries ranged from .73 to .87, Satisfaction ranged from .86 to .92, and Total QOL ranged from .91 to .93.

The Children's Depression Inventory (CDI; Kovacs, 1985) was used to measure youth depressive symptoms prior to pump-start. The CDI is a 17-item self-report questionnaire that has been used in many pediatric populations and has good psychometric properties (Kovacs, 1985). The published mean CDI score in a nonclinical school-aged population is 6.29 (Saylor, Finch, Spirito, & Bennett, 1984). In this sample, the internal consistency was good ($\alpha = .84$).

The Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997) was used to assess prepump level of anxiety and worry. The MASC is a 39-item questionnaire that asks children to rate how they have been thinking, acting, and feeling recently. The MASC has adequate reliability, internal consistency, and discriminant validity; the published mean score per item in a clinical population is 2.24 ($SD = 0.44$) (March et al., 1997; Rynn et al., 2006). This sample's internal consistency was good ($\alpha = .91$).

The Family Environment Scale (FES; Moos & Moos, 1974) measures parental perceptions of the family environment. Two scales (Conflict and Cohesion, 18 items) were included, asking parents to answer true or false to items concerning their family relationships. Mean subscale scores in nonclinical populations range between 3.3 and 3.7 for Conflict and between 6.6 and 7.5 for Cohesion (Loveland-Cherry, Youngblut, & Leidy, 1989). These subscales of the FES have been found to have sufficient reliability (Loveland-Cherry et al., 1989). Consistent with these findings, in this sample the internal consistency for the Conflict and Cohesion subscales was marginal ($\alpha = .61$ and .51, respectively).

A 39-item parent-report questionnaire developed by this research team was utilized to measure demographic characteristics, including ethnicity, family structure, and parent education. Medical information was obtained via medical record reviews conducted by trained research assistants, and included such variables as regimen prior to pump-start, HbA1C (metabolic control), and the number of diabetes-related hospitalizations.

Results Analysis

The data were analyzed using multilevel modeling (i.e., growth-curve modeling, hierarchical linear modeling;

HLM 6.04; Raudenbush, Bryk, & Congdon, 2007). HLM is a useful tool for analyzing longitudinal data because of the nature of the questions that can be asked about predictors of change trajectories. HLM uses data sets with missing data more efficiently than other analytic techniques (Vermeulen et al., 2005) by accommodating data that are missing at random and allowing participants missing one or more data points to be retained in analyses, thereby enhancing power (Singer & Willett, 2003). In addition, HLM treats time flexibly and can effectively utilize data collected at unevenly spaced intervals (Singer & Willett, 2003; Willett, Singer, & Martin, 1998). The reader is directed to Raudenbush and Bryk (2002) for more detail about HLM, and to DeLucia and Pitts (2006) for an in-depth description of growth curve analysis within a pediatric psychology framework.

HLM provides separate estimates of data collected from individuals and aggregates these estimates across all participants. The Level-1 model estimates separate intercept and regression slope parameters based on each child's QOL scores at four time points (i.e., initial screening, and 1, 6, and 12 months after transition to the pump). The Level-2 model simultaneously aggregates the Level-1 parameters and produces an intercept (QOL at initial screening) and slope (linear change in QOL across the study duration) for the entire sample, which can be modeled by inter-individual variables. In this study, several psychosocial (e.g., symptoms of anxiety and depression), medical (e.g., metabolic control and prepump regimen) and demographic variables (e.g., ethnicity and family structure) were considered as predictors of initial status and change in QOL. Reported in this article are: (a) the coefficient representing the magnitude of the effect (γ , similar to an OLS regression coefficient), (b) the SE of the estimate, and (c) an indication of the statistical significance (p).

Of the 69 eligible families who were successfully contacted, 53 consented to participate. Those who declined primarily cited time demands. Twenty-eight families completed all four measurement points, 10 completed only three measurement points, and 15 completed only the first two measurement points. Those participants without data at 6 months were no different from those with complete data on 10 of the 11 prepump variables considered; they only differed in that they had higher anxiety at prepump assessment, $t(51) = 2.43$, $p < .05$. Those without data at 12 months only differed in that they were more likely to have transitioned to the pump from a conventional regimen than from another intensive regimen, $t(51) = -2.42$, $p < .05$.

What Factors Are Related to Children's QOL Prior to Pump-Start?

For the first analysis, intraindividual family (conflict, cohesion, marital status, and number of adults in home), psychosocial (symptoms of anxiety and depression), medical (prepump regimen, metabolic control, and illness duration), and demographic variables (child and parent age, parent education, and ethnicity) were analyzed as predictors of QOL at the prepump assessment. The mean score for the Impact scale of DQOL-Y prior to pump transition was 44.8 ($SD = 7.8$), Worries, 15.6 ($SD = 4.5$), Satisfaction, 32.8 ($SD = 12.1$), and Total QOL, 92.3 ($SD = 22.4$). Prior to pump-start, CDI $M = 4.5$ ($SD = 4.8$), MASC $M = 39.1$ ($SD = 15.2$), FES conflict $M = 2.1$ ($SD = 1.6$), and FES cohesion $M = 9.1$ ($SD = 1.2$). Associations between the independent variables and each of the QOL subscales before pump-start are shown in Table I. Health-related QOL prior to pump transition was significantly poorer among children with more symptoms of anxiety or depression, transitioning from a conventional regimen, who were older, or with older parents. Family conflict and cohesion, number of adults in the home, marital status, parent education, ethnicity, illness duration, and HbA1C were not significantly associated with QOL.

Does QOL Change Over the Transition to the Pump?

In unconditional models (i.e., models with no Level-2 predictors of change trajectories), two scales of the health-related QOL measure (Satisfaction and Impact) improved from prior to the transition to insulin pump therapy through 12 months after the transition ($\gamma = -0.01$, $SE = 0.00$, $p = .03$ and $\gamma = -0.01$, $SE = 0.00$, $p = .04$, respectively). There was no main effect change of the trajectories of Total QOL or the Worries subscale.¹

Which Factors Are Associated with the Change in QOL Over this Transition?

Next, possible family, psychosocial, medical, and demographic factors were examined as moderators of the change in health-related QOL over the transition to the pump (Table II). The improvement in QOL was strongest for children with more prepump symptoms of anxiety or depression, with longer illness duration, who were older, from households with two or more adults, or with older parents. Those transitioning from conventional regimens

¹Significant nonlinear growth was found in QOL as well, the details of which can be obtained from the corresponding author.

Table 1. Which Factors Predict QOL Prior to Pump-Start?

	Impact			Worries			Satisfaction			Total QOL		
	γ	SE	p	γ	SE	p	γ	SE	P	γ	SE	p
FES cohesion	-0.78	0.93	.41	-0.10	0.60	.87	-0.62	1.38	.66	-2.29	2.86	.43
FES conflict	-0.29	0.59	.63	-0.06	0.33	.86	-0.67	0.90	.46	-0.63	1.68	.71
CDI	0.90	0.16	.00**	0.31	0.13	.02*	1.70	0.13	.00**	2.90	0.36	.00**
MASC	0.19	0.05	.00**	0.07	0.03	.02*	0.17	0.07	.02*	0.41	0.15	.01*
HbA1C	-1.45	1.04	.17	-0.53	0.58	.36	-1.96	1.70	.26	-2.48	3.14	.43
Illness duration	0.18	0.35	.60	0.15	0.19	.44	0.09	0.47	.85	0.74	0.94	.44
Prepump regimen	-3.04	1.99	.13	-1.90	1.12	.09	-6.75	2.61	.01*	-10.76	5.35	.05*
Child age	0.53	0.45	.24	0.77	0.27	.01*	1.66	0.63	.01*	3.02	1.25	.02*
Ethnicity	-1.43	2.87	.62	0.40	1.94	.84	-5.06	2.97	.09	-7.83	8.66	.37
No. of adults in home	-1.44	1.35	.29	-0.83	0.74	.27	2.55	2.08	.23	-0.12	3.64	.98
Parent age	0.36	0.14	.01*	0.16	0.06	.02*	0.43	0.24	.07	0.97	0.41	.02*
Parent education	4.27	3.77	.26	2.12	1.08	.06	0.42	5.29	.94	4.24	9.73	.66

* $p < .05$; ** $p < .01$ **Table 2.** Which Factors Predict Change in QOL?

	Impact			Worries			Satisfaction			Total QOL		
	γ	SE	p	γ	SE	p	γ	SE	P	γ	SE	p
FES cohesion	0.00	0.00	.52	0.00	0.00	.42	0.00	0.01	.79	0.00	0.01	.84
FES conflict	0.00	0.00	.50	0.00	0.00	.15	0.00	0.00	.30	-0.01	0.00	.14
CDI	0.00	0.00	.84	0.00	0.00	.58	0.00	0.00	.00**	0.00	0.00	.31
MASC	0.00	0.00	.33	0.00	0.00	.16	0.00	0.00	.01*	0.00	0.00	.13
HbA1C	0.00	0.01	.69	0.00	0.00	.86	0.00	0.00	.61	-0.01	0.01	.51
Illness duration	0.00	0.00	.00**	0.00	0.00	.04*	0.00	0.00	.23	-0.01	0.00	.01*
Prepump regimen	0.01	0.01	.25	0.00	0.00	.38	0.01	0.01	.06	0.02	0.01	.10
Child age	0.00	0.00	.40	0.00	0.00	.35	0.00	0.00	.05*	-0.01	0.00	.04*
Ethnicity	0.00	0.01	.69	0.00	0.01	.60	0.01	0.01	.24	0.01	0.02	.77
No. of adults in home	0.01	0.01	.16	0.00	0.00	.83	-0.01	0.01	.03*	0.00	0.01	.93
Parent age	0.00	0.00	.02*	0.00	0.00	.48	0.00	0.00	.27	0.00	0.00	.04*
Parent education	-0.02	0.01	.13	-0.01	0.00	.14	-0.02	0.01	.09	-0.04	0.02	.11

* $p < .05$; ** $p < .01$

trended toward stronger improvement. Family conflict and cohesion, metabolic control, ethnicity, parent education, and marital status did not significantly moderate change in QOL.

Does Metabolic Control Change Over the Transition to the Pump?

The trajectory of change in metabolic control over the transition to the pump was also examined as a dependent variable. Of the variables assessed, only illness duration predicted prepump HbA1C ($\gamma = 0.084$, $SE = 0.026$, $p = .003$); those with longer duration had higher HbA1C prior to pump-start. There was no main effect of change in HbA1C over the transition, and none of the examined variables significantly moderated the change.

Discussion

This study was an initial investigation into individual and family factors associated with the change in youth's diabetes-related QOL after transitioning to the insulin pump. Prior to the transition, health-related QOL was predicted by several individual psychosocial (i.e., depressive and anxiety symptoms), medical (i.e., prepump regimen), and demographic (i.e., child and parent age) characteristics, but not by family environment. During the transition, elements of children's QOL improved, and the amount of improvement was predicted by children's psychosocial (i.e., depressive and anxiety symptoms); medical (i.e., prepump regimen, illness duration); and demographic (i.e., child and parent age, number of adults in home) characteristics, but not by family environment. These findings

support the use of a contextual framework including awareness of children's psychosocial and medical status, as well as family structure and demographic factors when considering the trajectory of health-related QOL during this medical regimen transition.

Contrary to hypotheses, family conflict and cohesion were not significantly associated with children's prepump QOL or the amount of change in QOL in this study. This sample reported lower conflict and higher cohesion than previous studies with nonclinical, healthy samples, suggesting that the families in this study were doing remarkably well prior to transitioning to the pump. Consistent with the concerns raised by Loveland-Cherry et al. (1989), the marginal reliability of the FES subscales, as evidenced by their low internal consistency and limited range in this sample, may have introduced statistical error into the analyses and contributed to the lack of significant associations. The nonsignificant findings for conflict prior to pump-start are divergent from previous studies examining general QOL (Laffel et al., 2003), which may imply that the relationships between family context and general versus health-related QOL are different. Additionally, this study measured general conflict and did not assess the content of the family's fights. Further research into the source of conflict using measures with better psychometric properties and that are more specific to diabetes-related conflict is needed to more precisely investigate if, and in what ways, pump use might address family relationships specific to issues of illness and its management.

The nonsignificant findings for cohesion were consistent with null findings in previous research (Grey et al., 1998). However, there has been relatively little investigation of positive family constructs in this population, and the results of this study and those of Grey et al. (1998) do not rule out cohesion as important to families' experiences. Rather, evidence supporting its relevance to other diabetes outcomes (e.g., adherence, Cohen et al., 2004; metabolic control, Auslander et al., 1990) justifies further investigation of its role in health-related QOL. As with conflict, it may be useful to consider cohesion within an illness-specific framework to address more specifically the role of family relationships in illness management.

Prepump anxiety and depressive symptoms displayed an inverse relationship with QOL before and during the transition to the pump, indicating that youth with relatively more symptoms of depression and anxiety had poorer prepump QOL and showed greater improvement over the transition. The mechanisms by which this occurs remain unknown. This study utilized general psychological measures rather than those specific to depression or anxiety

related to diabetes adjustment and management. Future studies utilizing diabetes-specific measures and investigating how children's behaviors or cognitions change with pump use can help determine whether the pump is a particular relief to children who have more worries about diabetes management, and if the increased ability to engage in normative social activities may be related to a more positive affective experience. Whatever the mechanisms, it appears that children's emotional experiences may relate to their health-related QOL, particularly during transitional times, which has implications for opportunities for intervention. Furthermore, the youth in our sample had scores below published means, indicating that QOL had a relationship with psychosocial functioning even among children doing well, with a low number of depressive and anxiety symptoms. These findings suggest that adjustment-related issues should be considered even when they do not appear to be problems of clinical significance.

Prior to pump-start, children on a conventional regimen reported poorer health-related QOL than those on another intensive regimen. Because the participants were preparing for transition to the pump, those on a conventional regimen could have had very high expectations for the change, leaving them dissatisfied with the lifestyle limitations associated with their current regimen. In comparison, those on another intensive regimen may have been more familiar with, and had more realistic expectations, for the pump, as it was less of a drastic change (i.e., basal bolus regimens already allow for much lifestyle flexibility; Cogen et al., 2007). Furthermore, based on the changes in hospital practices for transitioning to the pump over the period of this study, it is likely that many families used intensive regimens before transitioning to the pump primarily as a step toward using the pump, although some families may have elected to transition more incrementally by first transitioning to the basal bolus before switching to the pump. The different motivations for using the basal bolus regimen may have impacted their prepump QOL, as those who were required to take this additional step may have been less satisfied with it. These data are unavailable, but specific expectations and motivations should be considered in future research related to transitions in medical regimens.

Prior to pump transition, older children in this sample had poorer QOL than younger children, consistent with the results of Graue et al. (2005). It is not unexpected that diabetes-related QOL might worsen with age, as management requirements may interfere with tasks of adolescent development; for example, the strict requirements of conventional regimens may hinder involvement in social

activities (e.g., spending more time with peers, going out to eat with friends, and sleepovers). Older youth in this study showed stronger improvement over the transition, suggesting that the lifestyle freedom of the pump may make these activities easier or more pleasant. Regression to the mean may be another possible explanation.

Although general family environment did not relate to children's health-related QOL in this study, other family-related contextual variables did have significant associations. Children in homes with two or more adults showed stronger improvement in QOL than those from one-parent families, consistent with previous findings indicating more cohesion and social and metabolic success in "traditional" (i.e., two-parent) versus single-parent family structures (Overstreet et al., 1995). This may relate to social support or more people with whom to share responsibilities, which should be further investigated. Additionally, parental age was significantly associated with prepump QOL and the change in QOL. This may simply be an artifact of the correlation between parent and child age, or may reflect the presence of an unknown third factor.

Results from previous studies are mixed regarding the relationship between metabolic control and diabetes-related QOL, but HbA1C generally seems to improve over the transition to the pump (Graue et al., 2005; Grey et al., 1998, 2001; McMahon et al., 2004; Weissberg-Benchell et al., 2003). In the current study, there was no main effect of change in HbA1C over the transition to insulin pump therapy. Moreover, exploratory analyses of metabolic control indicated that most of the variables of interest did not significantly relate to HbA1C prior to pump transition or moderate the amount of change in HbA1C, and metabolic control did not have a relationship with health-related QOL. These results are potentially related to these study participants being in relatively good control prior to starting pump therapy. The low mean HbA1Cs prior to pump-start limit the potential for improvement, possibly reflecting the practice of the hospital at the time of data collection to more often encourage pump use in children and adolescents already in adequate metabolic control.

The low variability and low mean psychosocial scores and greater attrition among youth with higher prepump anxiety are also reflective of the hospital's selection process for pump transition. Furthermore, the pump may not be available to all youth with diabetes, not only related to health issues, but also income, as the pump may not be fully covered by medical insurance. Those families who are approved to transition to the pump and able to afford it may differ from other families in terms of some of the

variables of interest in this study (e.g., health, family environment, and stress). The findings of this study are therefore limited to children with adequate regimen adherence and metabolic control, without major mental health concerns, and from families able to afford the substantial costs of this medical regimen. Current practices at this site now allow more children who are interested to use this regimen, yet financial considerations remain. Future studies of youth with a broader range of metabolic control, mental health, and SES are recommended, as they will be informative about health-related QOL and medical outcomes in a more generalizable sample.

As with all clinical research, this study had limitations, including its relatively small sample size, high education level, and general ethnic homogeneity. However, the proportion of Caucasian families is representative of the hospital's diabetes clinic population and reflects the higher incidence of type 1 diabetes among Caucasians (SEARCH for Diabetes in Youth Study Group et al., 2006). The use of general psychosocial measures limits the ability to clarify the illness-specific mechanisms underlying the relationships with diabetes-related QOL. Nevertheless, the use of well-established, standardized measures of family environment, depression, and anxiety allows for a developmental perspective in the investigation of illness-related adjustment. The QOL measure utilized in this study, while commonly used in the field at the time of data collection, was developed prior to the DCCT and is less relevant to modern insulin therapies including the insulin pump. Finally, reasons for changing regimens were not assessed, thus limiting the ability to hypothesize about individuals' QOL-related expectations for the pump. An examination of expectations for the pump is an important area for future research.

The attrition rate may also be of concern in interpreting findings. However, the analytic method utilized in this study (HLM) is specifically designed to support data sets with this type and amount of missing data and does so efficiently and effectively (Raudenbush & Bryk, 2002; Vermeulen et al., 2005). The use of four data points, despite not being complete for all participants, contributes substantially to the estimation of the parameters, thus strengthening the models and the conclusions drawn from these data (Willett et al., 1998).

The findings of this preliminary study suggest that it is important to assess children's psychosocial well-being and consider not only medical but also individual and contextual factors during transitional times in illness management. This information may be useful to inform or guide support programs or interventions during transitions.

Because families may choose to use the pump for the QOL and lifestyle benefits it can provide, this study also suggests that it may be useful to consider the developmental, psychosocial, and demographic factors linked to improvement in QOL during this transition. These results, along with follow-up studies, may aid in determining ideal candidates for the pump or those who might benefit most from the transition, including older youth with longer diabetes duration and more psychosocial difficulties, and may contribute to the development of programs to support children and families through this transition.

This initial investigation opens up questions for future research. It may be useful to examine how children and parents share responsibility for diabetes management tasks over time, and how this evolves with medical regimen changes. From a child–family transactional perspective, it may be beneficial to examine diabetes-specific and general family relationships with more precise, sensitive measures, and to consider parental psychosocial status in relation to the family environment and children’s health, QOL, and functioning over time. The participation of other family members (e.g., fathers, siblings) in diabetes management would also be an area to explore further. Finally, future research applying these findings to the development of support programs during transitional times may have direct clinical utility.

In sum, this study was an initial investigation into the role of child medical, demographic, and psychosocial factors and family environment variables in the improvement in children’s health-related QOL during the transition to a new, more intensive medical regimen. It provides a developmental and contextual perspective on changes in children’s adjustment to diabetes and its management, which may inform medical and psychological treatment and support during transitional periods.

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