The Relation Between Family Factors and Metabolic Control: The Role of Diabetes Adherence

Adam B. Lewin,[1,2] MS, Amanda D. Heidgerken,[2] PhD, Gary R. Geffken,[1,2,3] PhD,
Laura B. Williams,[1,2] MS, Eric A. Storch,[2,3] PhD, Kenneth M. Gelfand,[4] PhD, and
Janet H. Silverstein,[3] MD

[1]Department of Clinical and Health Psychology, University of Florida, [2]Department of Psychiatry, University of Florida, [3]Department of Pediatrics, University of Florida, and [4]Department of Psychology, Mount Washington Pediatric Hospital

Objectives   To examine family factors as predictors of metabolic control in children with type 1 diabetes and determine whether adherence behaviors mediate this relationship.   **Method**   Participants were 109 children (ages 8–18) and a parent. Measures of diabetes-specific family functioning and an adherence interview were completed. Glycosylated hemoglobin (HbA1c) was the index of metabolic control.   **Results**   Family functioning and adherence were strongly associated with metabolic control. Combined with demographic information, these constructs accounted for 49% of the variance in metabolic control. Age moderated the relation between aspects of family functioning and HbA1c. Path analyses suggest that adherence mediates the relationship between family functioning and metabolic control.   **Conclusions**   Family functioning and adherence behaviors are strongly related to a child's health status. Assessment of diabetes-specific family functioning, in addition to adherence, is an important factor in understanding metabolic control.

Key words   adherence; family functioning; mediator; metabolic control; type 1 diabetes.

A large body of research has investigated relations between diabetes-specific family variables and outcomes, such as adherence and metabolic control, in pediatric patients with type 1 diabetes. Associations between aspects of family functioning (specific to diabetes care) and metabolic control are well documented (McKelvey et al., 1993; Schafer, Glasgow, McCaul, & Dreher, 1983; Waller et al., 1986). For example, positive parental emotional support (e.g., expressing understanding regarding the difficulties of living with diabetes and the treatment regimen, relating to their child about having diabetes) is associated with improved metabolic control (McKelvey et al., 1993; Waller et al., 1986). Data from a longitudinal study support an association between family communication and improved metabolic control (Jacobson et al., 1994). Additionally, sufficient (but noncoercive) parental guidance with diabetes-related

care tasks is positively correlated with improved diabetes health status indicators such as metabolic control (McKelvey et al., 1993; Waller et al., 1986).

Studies have found that patients experiencing high levels of family conflict display poorer adherence or poorer metabolic control (Hauser et al., 1990; Klemp & La Greca, 1987; Miller-Johnson et al., 1994). Schafer et al. (1983) and Schafer, McCaul, and Glasgow (1986) found that negative and unsupportive parental behavior patterns related to diabetes care behaviors (e.g., coercion, nagging, threats, criticism, and scolding) are correlated with both poorer metabolic control and poorer regimen adherence. Further, in a study evaluating a parent–adolescent teamwork approach to diabetes management, adolescents in the intervention group reported significantly less parent–child conflict related to diabetes management [measured by the Diabetes Family Behavior Checklist

(DFBC)] and were in better metabolic control (Anderson, Ho, Brackett, & Laffel, 1999).

Moreover, appropriate parental supervision of diabetes care tasks is closely related to adherence and metabolic control. For example, Anderson, Auslander, Jung, Miller, and Santiago (1990) found that disagreements between parents and children regarding responsibility for diabetes-related tasks predicted poor metabolic control. In addition, these researchers found that poorer metabolic control was positively correlated with families in which neither the parent nor child assumed responsibility for diabetes-related tasks. Wysocki et al. (1996) also examined families' diabetes responsibility relative to their developmental level. Results indicated that children reporting more diabetes management responsibilities demonstrated less adherence and worse metabolic control.

Overall, these findings linking metabolic control to diabetes-specific family processes (such as parental involvement in diabetes tasks and the child's perception of the valence of diabetes-related parental behaviors and support) highlight the importance of these constructs. Further, Anderson and Laffel (1997) described diabetes-specific family functioning as critical constructs for assessments to optimize metabolic control and adherence outcomes. Although relations between *individual* family processes (e.g., responsibility, parental warmth) with metabolic control are relatively small, experts suggest that incorporating multiple diabetes-related family constructs might demonstrate a stronger connection with metabolic control (McKelvey et al., 1993). However, no known study has examined all of these diabetes-related family processes concurrently. When combined, these diabetes family processes may delineate a separate construct, related to adherence, which indirectly influences metabolic control. For example, Kovacs, Kass, Schnell, Goldston, and Marsh (1989) suggested that family behaviors associated with adherence might mediate the relationship between family functioning and metabolic control. Family behaviors related to diabetes management may facilitate or impede adherence to prescribed treatment and consequently affect metabolic control. Research by Miller-Johnson et al.

(1994) supported this premise—the study identified that ratings of parent and child conflict failed to contribute unique variance in metabolic control beyond that accounted for by adherence. Cohen, Lumley, Naar-King, Partridge, and Cakan (2004) also suggested that family dysfunction may affect metabolic control indirectly, via effects on adherence behaviors. Although data from that study did not support mediation, it is noteworthy that the measured family functioning processes in Cohen et al. (e.g., adaptability, cohesion) were general—not specific to diabetes. These findings suggest that further research is needed to verify mediation and to extend finding (Miller-Johnson et al.) to other family processes related to diabetes adherence.

Additionally, a child's age may moderate family functioning–metabolic control relations. Several analyses suggest that the relation between diabetes family functioning and adherence varies with age (Anderson & Laffel, 1997; Waller et al., 1986), with the relation between parental guidance and control and glycosylated hemoglobin (HbA1c) being weaker in adolescents than in younger children (McKelvey et al., 1993; Waller et al.). Similarly, both adherence and metabolic control relations with age are well documented (Johnson, 1992). Moreover, increased parent–child conflict (Wysocki et al., 2000) and decreased parental involvement (Anderson & Laffel) in diabetes self-care activities during adolescence suggest that age may moderate the mediating effect of adherence on the relation between family functioning and metabolic control.

Thus, the purpose of this study was to more fully explore the relations among family variables (i.e., parental guidance and control, parental warmth and caring, criticism and negativity, no responsibility for diabetes regimen), adherence, and metabolic control. Although several researchers have explored individual facets, no known investigation has examined the relation between this combination of multiple diabetes-specific, family-related adherence variables and metabolic control. Further, this study tests a model positing a more complete pathway by which family factors affect metabolic control via child adherence to diabetes regimen (Figure 1). Specifically, poor diabetes-specific family functioning is
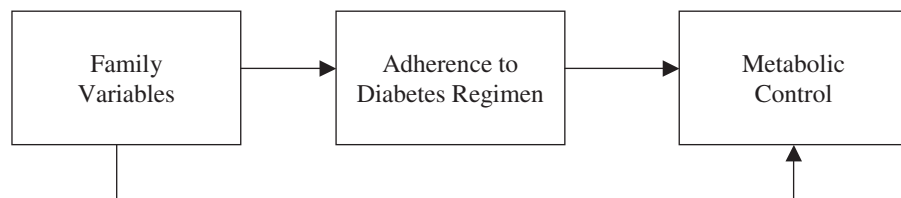

Figure 1. Theoretical mediating model of family variables, adherence, and metabolic control.

expected to relate to reduced adherence with the medical regimen, which in turn results in worse metabolic control. This potential mediating effect may offer a more comprehensive understanding of how the interrelations between family functioning and adherence result in poor metabolic control.

Therefore, this study addresses the following aims: (1a) to test the relation between a combination of diabetes family functioning constructs (i.e., parental guidance and control, parental warmth and caring, parental criticism and negativity, no responsibility for diabetes regimen) and metabolic control; (1b) to examine the relation of diabetes adherence (i.e., parental and child reports of regimen behaviors including insulin injections, blood glucose monitoring, diet, and exercise) to metabolic control; (2) to test whether age moderates the relation between diabetes family functioning and metabolic control; (3) to test a conceptual model where reports of adherence mediate the relations between diabetes family functioning factors and metabolic control.

Method
Participants and Procedure

Participants were 109 children with type 1 diabetes and their caregivers attending an outpatient pediatric diabetes clinic at a university-affiliated medical center. The sample consisted of 53 boys and 56 girls, ages 8.0–18.4 years (*M* = 13.7, *SD* = 2.5). The ethnic distribution was 78.0% Caucasian, 10.1% African American, 7.3% Hispanic, 2.8% Native American, and 1.8% representing other ethnic groups. Children participating in this study were from predominantly two-parent families (72.5%), and the mean family size was 4.02 (*SD* = 1.15). Of the remaining children, 25.7% were from single-mother families, and 1.8% were from single-father families. More mothers (81.7%) participated in the study compared to fathers (13.8%) and other caregivers (4.6%). The Hollingshead (1975) index suggested that approximately 60% of families participating in our study were below average in socioeconomic status (SES). On average, participants had been diagnosed with diabetes for 5.8 years (*SD* = 3.5, range 1–17). Mean HbA1c was 8.7% (*SD* = 1.7, range 5.4–14).

Caregivers and children were approached during their regularly scheduled clinic visits if they met the following study inclusion criteria: (a) ages 8–18 years, (b) a diagnosis of type 1 diabetes for at least 1 year, (c) living with and accompanied by their primary caregiver, and (d) no evidence of mental retardation. Signed informed consent and assent, approved by the institu-

tional review board, was obtained from each participant. The consent rate was 94%. Measures took approximately 25 min to complete, and children were interviewed separately from their parents. Participants were instructed to respond to all study measures on the basis of their behavior over the prior 3 months. Blood samples (collected by a finger-stick) for the HbA1c were obtained by trained clinic staff as part of each patient's visit.

Measures of Diabetes-Specific Family Functioning
Diabetes Family Behavior Scale (DFBS; Waller et al., 1986)

The DFBS is a measure of perceived family support completed by youth with type 1 diabetes. Only the 15-item warmth and caring (e.g., "my parent understands how I feel about having diabetes") and guidance and control (e.g., "my parent reminds me to test my blood sugar") subscales were used because of the aims of this study. Participants responded to statements on a five-point scale anchored by "all of the time" and "never." Waller et al. (1986) reported good internal consistency (α = .82 for both scales) and promising reliability (3-week test–retest reliability coefficients for the warmth and caring and guidance and control subscales were .79 and .83, respectively). Cronbach's α in our study were acceptable (α = .69 for the warmth and caring subscale; α = .76 for the guidance and control subscale).

Diabetes Family Behavior Checklist (Schafer et al., 1986)

The DFBC is a child-rated measure of family support of the child's diabetes self-care regimen. Only the seven-item nonsupportive family behavior domain was used. Children rated their parents on items such as how often does he or she "nag you about following your diet." Items are scored on a five-point Likert scale ranging from "never" to "at least once a day." Schafer et al. (1986) reported acceptable internal consistency for this scale (α = .60). Internal consistency for this sample was satisfactory (α = .76).

Diabetes Family Responsibility Questionnaire (DFRQ; Anderson et al., 1990)

The DFRQ assesses the family sharing of responsibilities concerning diabetes treatment. Both the parent and child completed this measure individually by reading 17 statements concerning diabetes management tasks and indicating which family member accepts responsibility for that specific task (i.e., parent, child, or both). A parent–child dyadic no-responsibility score is calculated on the basis of patterns of agreement and disagreement within the pair. Higher no-responsibility scores suggest that

neither the parent nor child take responsibility for aspects of diabetes care. For example, if the child indicates that the parent is responsible for a care task (e.g., remembering to take insulin) while the parent indicates that the child is responsible, this item is scored on the No-Responsibility Taken index. Anderson et al. (1990) reported good internal consistency for the DFRQ (α = .85). In this sample, α was .89.

Measurement of Adherence

Diabetes Self-Management Profile (DSMP; Harris et al., 2000)

The DSMP is a 23-item structured interview with an administration time of approximately 15 min. Questions assess five areas of diabetes management: insulin administration and dose adjustment, blood glucose monitoring, exercise, diet, and management of hypoglycemia. Items were responded to in an open-ended manner and were coded by trained interviewers. Most items are scored on a five-point scale derived from the specific domain of the question (e.g., "always eats more or gives less insulin," "frequently eats more or gives less insulin," "sometimes eats more or gives less insulin," "occasionally eats more or gives less insulin," "eats less than usual or gives more insulin"). All items summed to produce a total adherence score. Although there are no direct comparisons between the DSMP and other adherence measures in the extant literature, the predictive validity ($r = -.28$, $p < 0.01$; Harris et al., 2000) indicates that the DSMP accounts for a similar amount of variance in HbA1c compared with written self- and parent-report measures of adherence (e.g., the Self Care Adherence Inventory; Hanson, Henggeler, & Burghen, 1987). Additionally, Lewin et al. (in press-a) found that child ($r = -.60$) and parent ($r = -.54$) reports of adherence using the DSMP were strongly correlated with HbA1c. Advantages of the DSMP interview over available self-report measures of adherence include assessment of up-to-date aspects of diabetes care such as carbohydrate counting. Harris et al. (2000) found good internal consistency (α = .76) and

interobserver agreement (94%). Cronbach's α for our sample was acceptable (for child report α = .72; parent report α = .69).

Measurement of Metabolic Control

Metabolic control is a biological assay of health status operationalized via the glycated hemoglobin A1c test (GHb/HbA1c). HbA1c provides an estimate of glycemic control over the previous 2–3 months (American Diabetes Association, 2003). Blood samples were analyzed using a Bayer DCA 2000+.

Analyses and Results
Descriptive Analyses

Preliminary analyses were conducted to test for relations between demographic variables and study variables (HbA1c, adherence, and family functioning) for purposes of control in subsequent hierarchical multiple regression. Children from single-parent families (M = 9.5%) had significantly higher HbA1cs compared with children from two-parent families (M = 8.4%). HbA1c was weakly correlated with child's age (r = .23, $p < .05$) and duration with diabetes (r = .19, $p < .05$), but not with SES. All other demographic variables did not demonstrate significant effects on measures of diabetes-specific family functioning or on reports of adherence.

Study Aim 1: Regression Analysis of Family Functioning and Adherence on HbA1c

To examine the relation between multiple measures of diabetes-specific family factors and control, we conducted a hierarchical multiple linear regression in SPSS 11.0 (SPSS, Inc., 2001). Intercorrelations among predictor variables are summarized in Table I. To control for the influence of the child's age, duration with diabetes, and family structure (single-parent or two-parent family), we entered these variables into the regression equation in step 1, and these variables accounted for 11% of the

Table I. Intercorrelations Between Diabetes Family Measures, Adherence, and HbA1c

	Variable	1	2	3	4	5	6	7
1	HbA1c	—						
2	Child report of adherence	−.47**	—					
3	Parent report of adherence	−.41**	.42**	—				
4	Parental warmth and caring	−.38**	.35**	.26**	—			
5	Parental guidance and control	−.08	.25**	.21*	.21*	—		
6	No responsibility	.27**	−.15	−.09	−.06	.10	—	
7	Critical, negative parenting	.55**	−.37**	−.40**	−.29**	−.03	.12	—

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

Table II. Hierarchical Regression Analysis Predicting HbA1c from (a) Diabetes-Related Family Factors, (b) Child Report of Adherence, and (c) Parent Report of Adherence

Step	Variable(s)	R^2	ΔR^2	F	β
1		.11	.11	4.41**	
	Child age				.04
	Duration of diabetes				.17*
	Family structure				.18*
2		.45	.34	15.71***	
	No responsibility for diabetes management				.17*
	Child perception of parental guidance and control				−.01
	Child perception of parental warmth and caring				−.22
	Child report of critical, unsupportive parents				.45**
1		.11	.11	4.41**	
	Child age				.12
	Duration of diabetes				.15
	Family structure				.08
2	Child report of adherence	.26	.15	21.54***	−.42***
1		.11	.11	4.41**	
	Child age				.05
	Duration of diabetes				.17
	Family structure				.13
2	Parent report of adherence	.21	.10	13.36***	−.35***

All standardized regression coefficients and structure coefficients are from the final block of the regression.

*$p \leq .05$. **$p < .01$. ***$p < .001$.

variance in metabolic control, $F(3, 105) = 4.42$, $p < .01$. Considering that there were no a priori suppositions regarding the magnitude of the relation between each family functioning variable and metabolic control, each family predictor was entered simultaneously into the second block of the regression. Combined, the four diabetes-specific family functioning variables (i.e., DFBS parental warmth and caring, DFBC critical and negative parenting, DFBS guidance and control, and DFRQ parent–child dyad scores suggesting no-responsibility for the treatment regimen) explain an additional 34% of the variance in HbA1c, $F(7, 101) = 15.71$, $p < .001$. Results are summarized in Table II. This procedure was repeated to examine the relations between adherence and metabolic control. Separate regression equations were calculated for child and parent reports of adherence (Table II). Child report of adherence explained 15% of the variance in HbA1c, $F(1, 104) = 21.54$, $p < .001$, and parent report explained 10% of the variance in HbA1c, $F(1, 104) = 13.36$, $p < .001$.

Study Aim 2: Moderator Analysis of Age on the HbA1c and Family Functioning Relation

Baron and Kenny's (1986) guidelines for moderation were followed to examine whether child's age moderated the relation between diabetes-specific family functioning and metabolic control. According to these criteria, moderation is met if there is a significant interaction between the moderator (i.e., age) and a family functioning variable (e.g., parental warmth) after the effects of both the moderator and family functioning variables are controlled. Moderation was tested separately for all four family functioning variables by using hierarchical regression with metabolic control as the dependent variable. Family structure and duration with diabetes were entered into the regression first to control for covariates before interactions were tested. Child age and a family variable were added next as predictors into the regression, and the age by family functioning interaction was added into the final block. The only significant family functioning by age interaction was for child perception of critical and negative parenting related to diabetes, $F(1, 103) = 8.23$, $p = .005$; β $= .5$, $p = .005$. In teenagers (age 13 and above; $N = 63$), poor metabolic control was strongly correlated with critical and negative parenting ($r = .66$, $p < .001$). However, this relation was not found in younger children (ages 8–12; $N = 46$; $r = .19$, $p = .19$). Fisher's r-to-z tests showed a significant difference in the magnitude of the correlations ($p < .001$). This age selected as a cutoff for the moderator analysis in this sample was based on trends from the extant literature (Johnson et al., 1992) and clinical expectations. For example, Wysocki et al. (2000) described this age to be when parent–child conflict often increases. Further, Anderson and Laffel (1997) suggested

that diabetes management responsibilities shift from the parent to adolescent at this age.

Study Aim 3: Mediation Analysis—Family Functioning, Adherence, and Metabolic Control

Baron and Kenny's (1986) guidelines for mediation were followed to test a model of the influence of family variables on metabolic control via adherence. The following criteria are necessary for mediation: (I) the predictor (family functioning) should be significantly associated with the outcome (HbA1c), (II) the predictor should be significantly associated with the mediator (adherence), (III) the mediator should be associated with the outcome variable (with the predictor accounted for), and (IV) lastly, the addition of the mediator to the full model should reduce the relation between the predictor and criterion variable. Criterion I of mediation was met in Study Aim 1, with family variables predicting 34% of the variance in metabolic control. Regression techniques (as described in Study Aim 1) were used to identify the direct effect of family functioning on adherence (criterion II). Results indicated that family variables significantly predicted 31%, $F_{(4, 101)} = 8.94$, $p < .001$, of the variance in combined child- and parent-rated adherence, meeting the second requirement for mediation—child-rated adherence 24%, $F_{(4, 104)} = 6.4$, $p < .001$; parent-rated adherence 22%, $F_{(4, 104)} = 7.14$, $p < .001$. In accordance with criterion III of the guidelines, child and parent adherence predicted 6%, $F_{(2, 99)} = 5.39$, $p < .001$—child-rated adherence 5%, $F_{(1, 100)} = 5.6$, $p < .01$; parent-rated adherence 4%, $F_{(1, 100)} = 4.2$, $p < .01$—of the variance in metabolic control with the effects of family variables accounted for. Moreover, the relation between family variables and metabolic control was reduced from 34 to 18%, $F_{(4, 99)} = 8.86$, $p < .001$, when

adherence was accounted for, demonstrating criterion IV for mediation (Table III). Child-rated adherence (22%), $F_{(4, 100)} = 10.43$, $p < .001$, and parent-rated adherence report (25%), $F_{(4, 100)} = 11.73$, $p < .001$, also met criterion IV for mediation. The addition of the mediator reduced the size of the direct effect but did not reduce the effect to a nonsignificant value, suggesting partial mediation. As such, family factors were predictive of unique variance above and beyond adherence, indicating direct and indirect effects of family variables on metabolic control.

Analysis of the standardized beta weights in the final block of the model indicated a significant contribution of variance from child report of critical or negative or unsupportive parents, no-one taking responsibility for diabetes management, child perception of parental warmth and caring, child report of adherence, and duration with diabetes (Table III). Combined with demographic variables, family functioning and adherence predicted 49% of the variance in metabolic control. Of note, analysis of beta weights solely (child report of adherence $\beta = -.18$, $p = .04$; parent report of adherence $\beta = -.09$, $p = .31$) suggests that child report of adherence accounts for little variance in metabolic control, and that parent report of adherence does not significantly contribute to the variance in metabolic control. However, analysis of regression structure coefficients (child report of adherence $r_s = .67$, parent report of adherence $r_s = .59$), which are not suppressed or inflated by collinearity, demonstrates that beta weights for adherence are low because of multicollinearity between predictors, not poor relations with the outcome variable. This presence of multicollinearity between values of adherence and the family variables is as would be expected.

Given that a significant moderating effect of child age was found in Study Aim 2, the mediation model was

Table III. Mediation Regression Analysis Predicting HbA1c: Final Block of the Regression

Step	Variable(s)	R^2	ΔR^2	F	β	r_s
1		.11	.11	4.41**		
	Child age				.02	.71
	Duration of diabetes				.15*	.58
	Family structure				.12	.58
2		.30	.19	14.04***		
	Child report of adherence				−.18*	.67
	Parent report of adherence				−.09	.59
3		.49	.18	8.86***		
	No responsibility for diabetes management				.15*	.41
	Child perception of parental guidance and control				.04	.12
	Child perception of parental warmth and caring				−.17*	.56
	Child report of critical, negative, unsupportive parents				.38***	.82

All standardized regression coefficients and structure coefficients are from the final block of the regression.

*$p \leq .05$. **$p < .01$. ***$p < .001$.

tested separately for the two age groups (i.e., ages 9–12 years and ages 13–19 years) by using the aforementioned four criteria indicated by Baron and Kenny (1986). Separate regressions by using the previously described steps, indicated a significant decrease in the amount of variance accounted for in metabolic control by family functioning when adherence (parent and child report) variables are accounted for in the older group, changing from 50%, [$F(4, 56) = 16.10$, $p < .001$], to 29%, [$F(4, 54) = 9.43$, $p < .001$)], of variance accounted for in metabolic control. This pattern was not reflected in the younger group. No evidence of a mediating effect was found for younger children; family factors were not significantly related to the outcome variable (criterion I).

Discussion

This study examined the relations among family functioning specific to diabetes management, adherence to treatment regimen, and metabolic control. First, we investigated the relation between a combination of diabetes-related family factors and metabolic control. Regression analysis indicated that, taken together, diabetes-related family factors accounted for 34% of the variance in metabolic control. This study substantiated a stronger relation between diabetes-specific family factors and metabolic control than in the extant literature. This may be because previous examinations employed only single measures of diabetes-specific family functioning (Anderson et al., 1990; Schafer et al., 1986). Often, small but significant relations with HbA1c were identified. If combinations of measurements were examined, they were usually scales designed to assess the same construct (e.g., family responsibility; Wysocki et al., 1996). A major contribution of this study is providing the first integrated analysis of multiple diabetes family factors in terms of their relations with adherence and metabolic control. Another important finding of this study was that adherence reports explained sizable variance in metabolic control. Analysis of both the standardized regression weights and the structure coefficients suggests that despite multicollinearity between adherence reports and family functioning, adherence is related to metabolic control. Although several previous studies have substantiated a link between diabetes-related family factors and adherence with metabolic control, to our knowledge, our investigation is the first to have explained as much as 49% of the variance in HbA1c.

A secondary purpose of this study was to test the mediating role of adherence in the relation between diabetes-specific family factors and metabolic control. The mediating model suggests that negative family functioning processes have a negative impact on children's adherence behaviors and subsequent metabolic control. As such, this model posits that lack of diabetes-specific support behaviors and attitudes increases parent–child conflict, that in turn decreases children's willingness to comply with their prescribed regimen and decreases the parents' ability to monitor their child's adherence to regimen. Of note, this model was only supported in older children. This may reflect the influence of the history of conflict development on the parent–child relationship or the maturation process in which children acquire more diabetes-related independence as they mature.

Overall, children who reported more negative and critical relationships with their parents were in worse metabolic control. It is doubtful that this relation is unidirectional. More conceivable is that families become trapped in a coercive cycle or struggle for control (Patterson, 1974). An adolescent's nonadherent behaviors may elicit parent criticism, which in turn can lead to more struggles between parent and youth. Over time, the rate and intensity of parental negativity increases, fostering less child adherence. This is supported by our findings that age moderated the relation between reports of family diabetes-related behaviors and metabolic control. Child report of parental negativity and criticism (related to diabetes management) was not predictive of metabolic control in younger children. However, adolescents reporting more critical, negative, unsupportive relationships with their parents regarding their diabetes management had worse metabolic control, a finding that is consistent with that of previous studies.

Although child age did not moderate the relation between the other family functioning factors and metabolic control in this research, previous studies clearly document developmental changes in diabetes management responsibility (e.g., the shift of responsibilities from the parent to the adolescent; Anderson & Laffel, 1997). However, independent of age or developmental level, the overall dyadic lack of responsibility is predictive of poor health status. More specifically, in families where no one assumes responsibility for diabetes management, children were in worse metabolic control, a finding that is consistent with that of Anderson et al. (1990). When parents do not take responsibility for diabetes management themselves or cannot agree with the child regarding who has responsibility for each specific regimen components, it seems intuitive that children may be in worse metabolic control. Consistent throughout this age range, higher levels of positive parental

support were associated with better metabolic control. However, a significant association between parental guidance and control and metabolic control, at any age level, was not identified in this study. This construct was not related to parental negativity or parental responsibility, suggesting that although guidance and control were independent of other family processes, the construct was not related to metabolic control in this sample.

It is important to note the limitations of this study. Our participants were primarily of low SES, which limits generalizability. Additionally, although participants were informed that neither a parent nor physician will see their responses, there is the potential for report bias on the study measures. Johnson (1992) described limitations with child reports of adherence behaviors including biased responding to appear favorable to the health care provider. To address this limitation, we included an independently measured parent report of adherence. It is noteworthy that metabolic control does not moderate parent–child agreement on reports of adherence by using the DSMP (Lewin et al. in press-a). Although the use of multiple informants may help mitigate the issue of informant bias, other assessment measures of adherence such as the 24-hr recall method (Johnson et al., 1992) may be subject to less bias (La Greca, 1990). Also, it is possible that children's responding is less guarded on the measures of family functioning because their responses on these types of questions have not been associated with a history of reward or punishment contingencies (as is likely the case with reports of adherence). Administration of disease-nonspecific family functioning measures along with disease-specific questionnaires would have allowed for more comprehensive comparisons with previous studies. In addition, this study is cross-sectional and therefore directionality is theoretical.

The implications of this study extend both to the assessment of regimen adherence and to treatment. First, although a recent controlled trial of Behavior Family Systems Therapy (BFST) for families of children with type 1 diabetes identified improved adherence at 6- and 12-month follow-ups, no improvement in HbA1c was identified (Wysocki, Bubb, Greco, White, & Harris, 2001). However, BFST approaches in this study focused on improving general family functioning outcomes. Those authors suggest that future BFST studies should focus on type 1 diabetes-specific family functioning outcomes, a suggestion consistent with the data from our study. Second, contrary to previous studies, our data suggest that family behavior is strongly related to a child's health status, especially when multiple aspects of family functioning related to regimen behaviors are

considered in making the assessment. Therefore, when identifying barriers to adherence, clinicians should assess child perceptions of parental warmth and caring, negativity, and responsibility in addition to asking about their disease management behaviors. Further, assessment of family functioning and the provision of additional services in single-parent families seem warranted, given the mean difference in HbA1c of +1.1% compared with two-parent families. A reduction in HbA1c by 1% was associated with a 15–30% decrease in microvascular and neuropathic complications of diabetes, highlighting the clinical significance of this group difference (American Diabetes Association, 2003).

Importantly, methodology similar to ours is a rapid way of systematically collecting information about adherence and family functioning. These scales can be completed in a clinical setting, demand minimal training to score and administer, and require little time to complete. These brief screening tools of family-adherence dynamics can identify families for early intervention or therapy. If family patterns related to poor metabolic control are identified, appropriate referrals for further assessment and mental health services should be made. Our findings should be considered during interventions for children with poor metabolic control. Specifically, behavioral family-system approaches seem most beneficial for these problems. Instead of focusing exclusively on improving specific adherence behaviors, therapy should address instrumental outcomes, such as improving family communication patterns and reducing factors that promote and maintain conflictual interaction patterns specific to diabetes management (or inhibit warm and caring relationships). In addition to a solid understanding of issues surrounding diabetes treatment, therapists require process skills to optimally address adherence problems in the context of improving family dynamics related to diabetes management.

In the future, the family functioning–adherence–metabolic control relations, identified in the mediation model from this study, should undergo further exploration. For example, intervention studies based on this model may contribute additional understanding of these relations. Given the restricted SES and ethnicity of this study, these findings should be explored in a more diverse population. Also, a single questionnaire to assess the multiple dimensions of diabetes-specific family factors, based on common factors across instruments used in this study, should be developed. Given that improved health status and reduced diabetes-related complications are the clinical goals, the aim should be to develop family-adherence factors on the basis of their relation with

metabolic control. Future analyses should examine other factors that might relate to diabetes family functioning. For example, parents who already perceive themselves as overwhelmed might be less likely to be supportive of and responsible for their child's diabetes treatment regimen. Other examples include parental anxiety and depression, child behavioral problems, and recent family stressors (Lewin et al. in press-b). Lastly, future studies should examine the possible reciprocal interaction effects between the family diabetes variables, adherence behaviors, and metabolic control.

Acknowledgments

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