ARTICLE

Prediction of Adolescents' Glycemic Control 1 Year After Diabetes-Specific Family Conflict

The Mediating Role of Blood Glucose Monitoring Adherence

Marisa E. Hilliard, PhD; Shanna M. Guilfoyle, PhD; Lawrence M. Dolan, MD; Korey K. Hood, PhD

Objective: To test adherence to blood glucose monitoring (BGM) as a mediator between diabetes-specific family conflict and glycemic control (hemoglobin A_{1c} [HbA_{1c}] levels) for 1 year.

Design: Three waves of prospective data spanning 1 year.

Setting: Diabetes clinic in a large tertiary care children's hospital in the Midwestern United States.

Participants: One hundred forty-five dyads composed of an adolescent (aged 13-18 years) with type 1 diabetes mellitus and a parent.

Main Exposures: Adolescent- and parent-rated diabetes-specific family conflict and mean daily BGM frequency obtained through meter downloads.

Main Outcome Measure: Levels of HbA_{1c}, abstracted from the medical record.

Results: In separate general linear models, higher adolescent-rated family conflict scores at baseline predicted less frequent BGM at 6 months ($\beta = -0.08$ [$P = .01$]) and higher HbA_{1c} levels at 12 months ($\beta = 0.08$ [$P = .02$]). In the multivariate model including baseline conflict and BGM as predictors of HbA_{1c} levels, BGM was a significant predictor ($\beta = -0.24$ [$P = .007$]) and conflict was no longer significant ($\beta = 0.05$ [$P = .11$]), supporting the mediation hypothesis. Post hoc probing showed that BGM explained 24% of the variance in the conflict-HbA_{1c} link. The mediation between parent-reported conflict and HbA_{1c} levels via BGM adherence was partially supported (conflict predicting HbA_{1c} in the zero-order equation, $\beta = -0.24$ [$P = .004$]; multivariate equation, $\beta = 0.06$ [$P = .02$]), and BGM frequency explained 16% of the conflict-HbA_{1c} link.

Conclusions: Diabetes-specific family conflict in adolescence predicts deteriorations in BGM and subsequent glycemic control for at least 1 year. Results support ongoing intervention research designed to reduce family conflict and thus prevent a trajectory of declining adherence and glycemic control across adolescence.

Arch Pediatr Adolesc Med. 2011;165(7):624-629

Author Affiliations: Division of Behavioral Medicine and Clinical Psychology, Center for the Promotion of Treatment Adherence and Self-management (Drs Hilliard, Guilfoyle, and Hood), Division of Endocrinology (Dr Dolan), and Department of Pediatrics (Drs Hood and Dolan), Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio.

TYPE 1 DIABETES MELLITUS AFfects roughly 2 of every 1000 children and adolescents in the United States, and the incidence is increasing.[1,2] Management involves frequent monitoring of blood glucose levels (ie, BGM) and adjustment and administration of insulin therapy multiple times per day, as well as careful attention to nutritional intake and exercise. Declining adherence to the diabetes management regimen is typical in adolescence,[3-6] contributing to deteriorations in glycemic control[3,7] and putting teenagers at increased risk for diabetes-specific complications.[8,9] A number of individual factors are associated with these declines in adherence and control, such as physiological and cognitive changes, increasingly autonomous self-care, and spending more time away from home.[5,10,11] Family characteristics, such as continued parental involvement in management, less diabetes-specific family conflict, and ongoing support can buffer the impact of these risks and are linked with sustained adherence and less deterioration in glycemic control.[10,12-17] However, the longitudinal impact of family factors on adherence and glycemic control in adolescence has not been thoroughly examined.

A family variable that consistently emerges as a correlate of adolescent adherence and glycemic outcomes is diabetes-specific family conflict.[14,15,18] Increasing autonomy is typical of adolescence,[19] and parents tend to be less involved in diabetes management as their teenaged children are expected to take on increasing re-

sponsibility.[20,21] Conflicts can emerge as teenagers with diabetes and their parents negotiate transitions in how and by whom diabetes management tasks are completed.[20-22] Cross-sectional and intervention studies have linked higher levels of family conflict with less frequent BGM, a behavioral indicator of diabetes treatment adherence.[15,18,23-26] There is an implicit assumption that a family environment characterized by conflict is a barrier to adolescent adherence, which contributes to poorer glycemic control. However, these links and the mechanisms by which family-level factors affect glycemic outcomes have not been tested over time. In the context of rapid developmental changes and the increased risks to diabetes-specific outcomes that are typical of adolescence, understanding the degree to which family-level factors may influence subsequent glycemic control and the mechanisms by which glycemic control is affected is critical for timely identification and intervention to ultimately improve health outcomes.

The aims of this study were to investigate the longitudinal and mediational associations between diabetes-specific family conflict, BGM adherence, and glycemic control as measured by hemoglobin A_{1c} (HbA_{1c}) levels. First, drawing on previous data demonstrating a strong association between conflict and glycemic control,[14,16,24] we hypothesized that adolescent- and parent-rated family conflict would predict HbA_{1c} levels 1 year later. Second, given existing cross-sectional support for an indirect relationship between conflict and HbA_{1c} levels through adherence,[15,18,25] we also hypothesized that BGM frequency during the year would mediate the link between baseline conflict and 12-month HbA_{1c} levels.

METHODS

PARTICIPANTS

Participants were adolescents aged 13 to 18 years with type 1 diabetes mellitus (mean [SD] age, 15.5 [1.4] years) and a parent of each. Of the 166 families approached to participate in the study, 150 (90.4%) consented/assented and provided baseline data. Data were available from 147 participant dyads at 6 months (98.0% retention rate) and 145 at 12 months (96.7% retention rate). Missing data points were primarily attributable to our inability to make contact at follow-up. The sample was 51.3% female, largely white (86.0%), from 2-parent families (74.7%), and covered by private insurance (84.7%). Most of the parents (84.7%) were mothers and nearly one-half (46.7%) had earned a college degree or beyond. At baseline, the mean (SD) duration of diabetes was 6.0 (3.9) years, mean (SD) HbA_{1c} level was 8.8% (1.9%) (to convert HbA_{1c} levels to a proportion of total Hb, multiply by 0.01), and most (63.3%) were receiving continuous subcutaneous insulin infusion (CSII).

PROCEDURE

Eligibility criteria included adolescents presently receiving multidisciplinary diabetes care at a tertiary pediatric medical center, diagnosis of type 1 diabetes mellitus, fluency in English, and the absence of a severe psychiatric, neurocognitive, or other serious chronic medical condition that would interfere with the ability to participate. A trained research assistant obtained written informed consent and assent and administered questionnaires at clinic visits. Data were collected in 3 waves, covering approximately 1 year (mean [SD] time to first follow-up from baseline, 7.0 [1.7] months; to second follow-up from baseline, 13.4 [2.3] months). Participants received $10 for their time and effort at each visit. The study was approved by the hospital's institutional review board.

MEASURES

Adolescents and caregivers rated diabetes-specific family conflict using the revised Diabetes Family Conflict Scale.[24] The Diabetes Family Conflict Scale assesses how frequently parents and adolescents argue about 19 tasks of diabetes management (eg, remembering to check blood glucose levels and increasing or decreasing the insulin dose depending on results). Possible scores range from 19 to 57, with higher scores reflecting more conflict. For this study, baseline Diabetes Family Conflict Scale scores were used as the independent variables. The mean (SD) adolescent-reported score was 26.0 (4.8) (range, 19-41), and the caregiver-reported score was 25.9 (5.4) (range, 19-57). These rates are similar to published reports in other convenience samples.[24] The Diabetes Family Conflict Scale has strong psychometric properties,[24] and internal consistency was adequate for both reporters in this sample (adolescents, $\alpha = 0.80$; caregivers, $\alpha = 0.86$).

The frequency of BGM was used as the indicator of adherence to the diabetes management regimen. Frequency of BGM was obtained through meter downloads at regular clinic visits, abstracted from the medical record at each time point, and averaged for the 14 days before each download. In this study, BGM frequency at 6 months was used as the hypothesized mediator. In the mediation analyses, BGM data were available from meter downloads for 62.8% of the sample. In the absence of more objective data, medical record reviews reflecting clinician review of meter data or frequency assessment based on clinic visit were available for 23.0% and self-report was available for 14.2%. There were no differences in BGM frequency ($P = .46$) or HbA_{1c} levels ($P = .61$) depending on the source of BGM frequency data.

The main outcome measure, HbA_{1c} level, was collected at regular diabetes clinic visits and abstracted from the medical record at each time point. Participants provided a sample of blood for HbA_{1c} level determination, measured by a commercially available analyzer (DCA+ 2000; Bayer Inc, Tarrytown, New York) (reference range, 4.3%-5.7%). For this study, 12-month HbA_{1c} level was used as the dependent variable.

Sociodemographic data (eg, adolescent age, sex, and ethnicity; caregiver marital status, sex, and education; and insurance coverage) were reported by caregivers on a background form created for this study. Medical data (eg, illness duration, insulin regimen [injections vs CSII], and HbA_{1c} level) were verified through medical record review conducted by trained research assistants.

DATA ANALYTIC PLAN

Means, correlations, and analyses of variance were calculated to examine bivariate associations between key study variables (ie, diabetes-specific family conflict, BGM adherence, and HbA_{1c} levels). Mediation analyses were conducted using a series of multivariate general linear models in the Baron and Kenny[27] framework. All measured medical and sociodemographic variables (ie, adolescent age, sex, and ethnicity; caregiver marital status, sex, and education; illness duration; insulin regimen; HbA_{1c} levels; and insurance coverage) were included as covariates in each equation to account for the broader context in which the adolescents live and to examine their contributions to the outcomes. Two parallel models were tested using adolescent- and parent-reported conflict. In the first step of the mediation model, baseline conflict and covariates were examined as pre-

Table 1. Correlations Between Variables at Each Time Point

Variable, Time Point	Mean (SD)	Correlation, *r*										
		1	2	3	4	5	6	7	8	9	10	11
Conflict score[a]												
1. Baseline	26.0 (4.8)											
2. 6 mo	25.2 (5.8)	0.51[c]										
3. 12 mo	24.4 (4.8)	0.46[c]	0.52[c]									
Conflict score[b]												
4. Baseline	25.9 (5.4)	0.58[c]	0.42[c]	0.44[c]								
5. 6 mo	25.1 (5.3)	0.44[c]	0.57[c]	0.41[c]	0.65[c]							
6. 12 mo	24.2 (4.2)	0.38[c]	0.26[c]	0.40[c]	0.62[c]	0.67[c]						
BGM frequency, per day												
7. Baseline	3.8 (1.7)	−0.28[c]	−0.23[c]	−0.12	−0.34[c]	−0.35[c]	−0.22[d]					
8. 6 mo	3.1 (1.8)	−0.23[c]	−0.20[d]	−0.15	−0.22[c]	−0.20[d]	−0.15	0.66[c]				
9. 12 mo	3.2 (1.8)	−0.10	0.06	−0.13	−0.25[c]	−0.15	−0.16	0.48[c]	0.51[c]			
HbA_{1c} level, %												
10. Baseline	8.8 (1.9)	0.33[c]	0.36[c]	0.32[c]	0.38[c]	0.37[c]	0.29[c]	−0.45[c]	−0.35[c]	−0.30[c]		
11. 6 mo	9.1 (2.1)	0.25[c]	0.33[c]	0.31[c]	0.38[c]	0.34[c]	0.24[c]	−0.43[c]	−0.40[c]	−0.29[c]	0.75[c]	
12. 12 mo	8.9 (1.8)	0.24[c]	0.20[d]	0.38[c]	0.28[c]	0.28[c]	0.37[c]	−0.20[d]	−0.34[c]	−0.37[c]	0.62[c]	0.68[c]

Abbreviations: BGM, monitoring of blood glucose levels; HbA_{1c}, hemoglobin A_{1c}.
SI conversion factor: To convert HbA_{1c} level to a proportion of total Hb, multiply by 0.01.
[a] Indicates adolescent-reported diabetes-specific family conflict as measured by the Diabetes Family Conflict Scale.[24] Possible scores range from 19 to 57, with higher scores reflecting more conflict.
[b] Indicates parent-reported diabetes-specific family conflict as measured by the Diabetes Family Conflict Scale.[24]
[c] $P<.01$.
[d] $P<.05$.

Table 2. Mediation Analysis Using Adolescent-Reported Family Conflict

Variable	β Coefficient[a]	*P* Value	Model *F* Value
Step 1: Baseline conflict predicting 6-mo BGM		<.001	3.76
Age	−0.32	.002	
Family conflict	−0.08	.01	
Step 2: Baseline conflict predicting 12-mo HbA_{1c} level		.003	2.83
Insulin regimen, injections	0.71	.03	
Caregiver marital status, single	0.94	.02	
Family conflict	0.08	.02	
Step 3: Baseline conflict and 6-mo BGM predicting 12-mo HbA_{1c} level		<.001	3.47
Insulin regimen, injections	0.73	.03	
Caregiver marital status, single	0.88	.02	
BGM frequency	−0.24	.007	
Family conflict	0.05	.11	

Abbreviations: BGM, monitoring of blood glucose levels; HbA_{1c}, hemoglobin A_{1c}.
[a] All variables in the regression equation were controlled for. All hypothesized covariates were included in all equations; only significant covariates are included in the table.

dictors of BGM frequency at 6 months. Conflict and covariates were then tested as predictors of HbA_{1c} levels at 12 months. In the final step of the model, baseline conflict, 6-month BGM adherence, and covariates were tested as predictors of 12-month HbA_{1c} level. We conducted the Sobel test to test for the significance of the mediation and performed post hoc probing to calculate the direct and indirect effects of the mediator.[28]

RESULTS

DESCRIPTIVE ANALYSES

Adolescent- and parent-reported diabetes-specific family conflict scores were significantly correlated with BGM frequency at baseline and at 6 months ($r=-0.20$ to $r=-0.34$ [$P<.05$]) (**Table 1**). At all 3 time points, conflict scores were correlated with HbA_{1c} levels ($r=0.33$ to $r=0.38$ [$P<.01$]), and BGM frequency and HbA_{1c} levels were also correlated ($r=-0.37$ to $r=-0.45$ [$P<.01$]). Conflict scores reported by mothers were significantly higher (mean, 26.2) than those reported by fathers (mean, 21.7) ($F_{1,143}=10.0$ [$P=.002$]). Therefore, caregiver sex was included as a covariate in all subsequent analyses.

MEDIATION

Mediation analyses using adolescent report are summarized in **Table 2**. The first regression equation (baseline adolescent-reported family conflict and covariates predicting 6-month BGM frequency) was significant ($F_{10,136}=3.76$ [$P<.001$; $R^2=0.22$]). Less frequent BGM was

predicted by more family conflict (β = –0.08 [P = .01]). This β coefficient indicates that a 12-point rise in diabetes-specific family conflict would result in a decrease of 1 blood glucose level check per day. Older age also predicted less frequent BGM (β = –0.32; P = .002). This step showed that conflict at baseline predicted the hypothesized mediator, BGM frequency at 6 months, which fulfills the first step of the mediation analysis.

The second equation (conflict and covariates predicting 12-month HbA_{1c} level) was significant ($F_{10,136}$ = 2.83 [P = .003; R^2 = 0.17]). Higher HbA_{1c} values were predicted by more family conflict (β = 0.08 [P = .02]), with a 6-point rise in conflict resulting in an increase of 0.5% in HbA_{1c} level (eg, 9.0% to 9.5%). Single caregiver marital status (β = 0.94 [P = .02]) and use of an insulin injection regimen compared with CSII (β = 0.71 [P = .03]) were also significant predictors of higher HbA_{1c} values. These data fulfill the second step of the mediation analysis, that conflict was associated with the hypothesized outcome, glycemic control. When baseline HbA_{1c} level was included in the regression equation predicting HbA_{1c} level at 12 months, it was the only significant predictor. To examine family and behavioral links with glycemic outcomes, baseline HbA_{1c} levels were thus removed from this and all subsequent analyses.

The final model (conflict, BGM, and covariates predicting HbA_{1c} level) was also significant ($F_{11,131}$ = 3.47 [P < .001; R^2 = 0.23]), with BGM a significant predictor (β = –0.24 [P = .007]) and conflict no longer significant (β = 0.05 [P = .11]). Therefore, the data supported the mediation hypothesis. In this model, as BGM frequency decreased by 2, HbA_{1c} levels increased by 0.5%. The use of insulin injections vs CSII (β = 0.73 [P = .03]) and single caregiver marital status (β = 0.88 [P = .02]) at baseline were significant covariates of a higher HbA_{1c} level 1 year later. The Sobel test approached significance (z = 1.88; SE, 0.01 [P = .06]), and post hoc probing of effects[27] showed that 6-month BGM frequency explained 24% of the variance in the association between baseline conflict and 12-month HbA_{1c} level.

When the mediation analysis was conducted a second time using parent-reported family conflict, the steps for testing mediation were met and partial mediation was indicated. Six-month adherence significantly predicted 12-month HbA_{1c} level (β = –0.24 [P = .007]) and the significance of baseline parent-reported conflict decreased when BGM frequency was in the model (β = 0.06 [P = .02, in contrast to P = .004 in the zero-order equation]). In the multivariate model, a decrease of 2 blood glucose level checks per day resulted in an increase of 0.5% in HbA_{1c} level. Private insurance (β = 1.02 [P = .03]) and single caregiver marital status (β = 0.97 [P = .009]) at baseline were significant covariates of a higher HbA_{1c} level 1 year later. The Sobel test was not significant for parent-reported conflict scores (z = 1.62; SE, 0.01 [P = .11]), and post hoc probing demonstrated that 6-month BGM frequency explained 16% of the parent-reported conflict-HbA_{1c} link.

COMMENT

Data show that family conflict around diabetes management during adolescence predicts glycemic control 1 year later, and BGM adherence is a mediator of this relationship. This study is, to our knowledge, the first to demonstrate a behavioral mechanism by which family-level factors affect diabetes health outcomes over time. This is consistent with findings from previous cross-sectional and intervention studies that higher diabetes-specific family conflict is associated with poorer diabetes outcomes.[16,18,23,24] The current study's findings extend previously published literature by (1) providing evidence of a longitudinal link between conflict and HbA_{1c} level and (2) highlighting a temporal order to this indirect effect through BGM adherence.

Given the important role of parents and the family environment in adolescent diabetes management,[13,15,20] families who argue more about diabetes and cooperate less in its management likely encounter more barriers to adhering to the multiple aspects of the diabetes regimen. For example, more parent-teen conflict about diabetes may interfere with parents' ability to monitor, collaborate with, and be involved in their adolescents' diabetes management, which is known to decrease adherence and self-care rates and to have negative effects on glycemic control.[12,13,29] Adolescents from families in which there is a high level of conflict about diabetes may avoid diabetes care tasks to avoid conflict. They may also be less able to communicate effectively or solve adherence problems with their parents, which can have a detrimental effect on their ability to execute the tasks of diabetes care accurately and subsequently influence HbA_{1c} levels.[26,30] In addition, conflict contributes to mood problems, which are known to detract from adherence and glycemic control.[24,31]

Results were similar but less robust for parent-reported conflict: adherence partially mediated the association between diabetes-specific conflict and HbA_{1c} levels and accounted for a smaller percentage of the variance in glycemic control. The divergent results for the mediation analyses using adolescent- vs parent-rated diabetes-specific family conflict highlight the importance of adolescents' perspectives on the family environment in relation to diabetes regimen adherence and HbA_{1c} levels. These findings are consistent with previous research[32] demonstrating a stronger association between adolescent report of parent involvement and health outcomes compared with parent ratings. These findings suggest that, at this developmental stage, adolescents' perceptions of family functioning are increasingly important in contrast to parents' perspectives. As teens are more consistently involved in BGM than their parents, their experiences of barriers to adherence (eg, diabetes-specific conflict) appear to be particularly relevant to their execution of diabetes management tasks.

It is well established that adherence rates decrease as children and adolescents get older,[3,4] and our results are similar. Although age was a significant covariate of adherence, it did not retain significance in the equations predicting HbA_{1c} levels, suggesting that other factors likely have a stronger direct association with biological outcomes. Specifically, medical factors, such as the mode of insulin administration, and family characteristics, such as caregiver marital status and diabetes-specific family conflict, were associated with later glycemic control. Consistent with previous research,[33] we found evidence of

small positive links between CSII use and glycemic control in this sample. However, this link is likely bidirectional because patients with better glycemic control may be more likely to be treated with CSII. In addition, as has been found in a previous report,[17] unmarried caregiver marital status was associated with additional risk for higher HbA_{1c} levels. In single-parent households, caregivers may not be able to monitor their children's diabetes self-care behaviors as much, and there may be increased stress or burden of care that could contribute to glycemic outcomes. Because this was not the focus of the present study, confirmatory conclusions about the mechanisms by which family structure affects HbA_{1c} levels cannot be drawn and should be further examined.

The key implication of this study is that diabetes-specific family conflict has a lasting negative effect on BGM adherence and glycemic control in adolescence. Early identification and treatment of diabetes-specific family conflict are critical to prevent a trajectory of declining adherence and glycemic control across the teenage years. The β coefficients in the mediation models indicated that BGM adherence had the largest influence on HbA_{1c} levels. Clinically meaningful changes in HbA_{1c} levels can be achieved through increased BGM frequency. One way to achieve clinically meaningful changes is to reduce diabetes-related family conflict, and it appears that a significant reduction in conflict is needed to affect BGM and glycemic control. There are a number of empirically supported prevention and intervention strategies that address family functioning and regimen adherence, including family-based coping and problem-solving programs.[23,26,34] These interventions have demonstrated improvements in adherence behaviors and glycemic control over time and have also been linked to improvements in the parent-adolescent relationship.[23,26] The results of the present study dovetail with the findings of these treatment outcome studies and support ongoing investigation and dissemination of effective interventions to decrease family conflict about diabetes, support positive family interactions, enhance regimen adherence, and thus promote optimal health outcomes for adolescents with diabetes.

As with all clinical research, this study has limitations. The sample consisted primarily of white adolescents with married, educated parents; as such, our findings may not be representative of youth from diverse backgrounds who are managing diabetes. Given the significant findings regarding the link between the insulin administration method and HbA_{1c} levels, associations among family factors, adherence, and HbA_{1c} levels may also vary for youth who receive insulin through injections vs CSII. We did not include previous HbA_{1c} levels in the models because they account for a disproportionate degree of the variance in later HbA_{1c} levels and thus would preclude our ability to address clinically relevant questions regarding associations between family conflict and behavioral adherence. Finally, it is plausible that the causal pathway between diabetes-specific family conflict and HbA_{1c} levels may also occur in the reverse direction from the one tested herein (ie, higher HbA_{1c} levels lead to more family conflict about diabetes management). Exploratory analyses revealed that poorer glycemic control significantly predicted higher diabetes-specific family conflict (results not shown), and future examinations using more time points are planned to examine the bidirectionality of their influences over time.

The findings of this study raise a number of important questions to be investigated in future research. In light of the somewhat discrepant results for adolescent- and caregiver-reported diabetes-specific conflict, the differences between parents' and adolescents' perceptions of conflict and the associations with important diabetes management processes (eg, family teamwork, communication, and autonomy) and outcomes (eg, adherence and HbA_{1c} levels) should be further investigated.[32] Findings would have implications for clinicians and researchers gathering data about the family environment from both parents and adolescents. Because families may argue about various aspects of diabetes management,[24] it may also be valuable to investigate the associations between diabetes-specific family conflict around direct (eg, remembering to check blood glucose levels and administering insulin) vs indirect (eg, ordering supplies and making appointments) management tasks and adherence and glycemic outcomes over time.

Adolescence is a period of increased risk for erratic adherence and poor glycemic control.[4,6,13,25] These data demonstrate that the quality of family interactions plays an important role in how adolescents achieve and maintain glycemic control for at least 1 year and that the adolescent's adherence to the diabetes regimen is a key factor in the diabetes-related outcomes experienced. Results of this study support treatment efforts for both family relationships and regimen adherence to improve glycemic control in adolescents.

Accepted for Publication: February 2, 2011.
Correspondence: Korey K. Hood, PhD, Division of Behavioral Medicine and Clinical Psychology, Center for the Promotion of Treatment Adherence and Self-management, Cincinnati Children's Hospital Medical Center, 3333 Burnet Ave, MLC 7039, Cincinnati, OH 45229 (korey.hood@cchmc.org).
Author Contributions: *Study concept and design:* Hilliard, Guilfoyle, and Hood. *Acquisition of data:* Hood. *Analysis and interpretation of data:* Hilliard and Hood. *Drafting of the manuscript:* Hilliard and Hood. *Critical revision of the manuscript for important intellectual content:* Guilfoyle, Dolan, and Hood. *Statistical analysis:* Hilliard and Hood. *Obtained funding:* Hood. *Administrative, technical, and material support:* Hood. *Study supervision:* Dolan and Hood.
Financial Disclosure: None reported.
Funding/Support: This research was supported by career development award K23 DK077340 from the National Institutes of Health (Dr Hood).

REFERENCES

1. SEARCH for Diabetes in Youth Study Group; Liese AD, D'Agostino RB Jr, Hamman RF, et al. The burden of diabetes mellitus among US youth: prevalence estimates from the SEARCH for Diabetes in Youth Study. *Pediatrics.* 2006;118(4):1510-1518.
2. Writing Group for the SEARCH for Diabetes in Youth Study Group; Dabelea D,

Bell RA, D'Agostino RB Jr, et al. Incidence of diabetes in youth in the United States. *JAMA*. 2007;297(24):2716-2724.
3. Johnson SB, Kelly M, Henretta JC, Cunningham WR, Tomer A, Silverstein JH. A longitudinal analysis of adherence and health status in childhood diabetes. *J Pediatr Psychol*. 1992;17(5):537-553.
4. Kovacs M, Goldston D, Obrosky DS, Iyengar S. Prevalence and predictors of pervasive noncompliance with medical treatment among youths with insulin-dependent diabetes mellitus. *J Am Acad Child Adolesc Psychiatry*. 1992;31(6):1112-1119.
5. La Greca AM, Follansbee D, Skyler JS. Developmental and behavioral aspects of diabetes management in youngsters. *Child Health Care*. 1990;19(3):132-139.
6. Weissberg-Benchell J, Glasgow AM, Tynan WD, Wirtz P, Turek J, Ward J. Adolescent diabetes management and mismanagement. *Diabetes Care*. 1995;18(1):77-82.
7. Hood KK, Peterson CM, Rohan JM, Drotar D. Association between adherence and glycemic control in pediatric type 1 diabetes: a meta-analysis. *Pediatrics*. 2009;124(6):e1171-e1179. doi:10.1542/peds.2009-0207.
8. Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med*. 1993;329(14):977-986.
9. Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Research Group. Retinopathy and nephropathy in patients with type 1 diabetes four years after a trial of intensive therapy. *N Engl J Med*. 2000;342(6):381-389.
10. Helgeson VS, Siminerio L, Escobar O, Becker D. Predictors of metabolic control among adolescents with diabetes: a 4-year longitudinal study. *J Pediatr Psychol*. 2009;34(3):254-270.
11. Holmes CS, Chen R, Streisand R, et al. Predictors of youth diabetes care behaviors and metabolic control: a structural equation modeling approach. *J Pediatr Psychol*. 2006;31(8):770-784.
12. Ellis DA, Podolski CL, Frey M, Naar-King S, Wang B, Moltz K. The role of parental monitoring in adolescent health outcomes: impact on regimen adherence in youth with type 1 diabetes. *J Pediatr Psychol*. 2007;32(8):907-917.
13. Wysocki T, Nansel TR, Holmbeck GN, et al; Steering Committee of the Family Management of Childhood Diabetes Study. Collaborative involvement of primary and secondary caregivers: associations with youths' diabetes outcomes. *J Pediatr Psychol*. 2009;34(8):869-881.
14. Anderson BJ. Family conflict and diabetes management in youth: clinical lessons from child development and diabetes research. *Diabetes Spectrum*. 2004;17(1):22-26. doi:10.2337/diaspect.17.1.22.
15. Hauser ST, Jacobson AM, Lavori P, et al. Adherence among children and adolescents with insulin-dependent diabetes mellitus over a four-year longitudinal follow-up, II: immediate and long-term linkages with the family milieu. *J Pediatr Psychol*. 1990;15(4):527-542.
16. Lewin AB, Heidgerken AD, Geffken GR, et al. The relation between family factors and metabolic control: the role of diabetes adherence. *J Pediatr Psychol*. 2006;31(2):174-183.
17. Overstreet S, Goins J, Chen RS, et al. Family environment and the interrelation of family structure, child behavior, and metabolic control for children with diabetes. *J Pediatr Psychol*. 1995;20(4):435-447.
18. Miller-Johnson S, Emery RE, Marvin RS, Clarke W, Lovinger R, Martin M. Parent-child relationships and the management of insulin-dependent diabetes mellitus. *J Consult Clin Psychol*. 1994;62(3):603-610.
19. Beyers W, Goossens L, Vansant I, Moors E. A structural model of autonomy in middle and late adolescence: connectedness, separation, detachment, and agency. *J Youth Adolesc*. 2003;32:351-365. doi:10.1023/A:1024922031510.
20. Palmer DL, Berg CA, Wiebe DJ, et al. The role of autonomy and pubertal status in understanding age differences in maternal involvement in diabetes responsibility across adolescence. *J Pediatr Psychol*. 2004;29(1):35-46.
21. Hanna KM, Guthrie DW. Parental involvement in adolescents' diabetes management. *Diabetes Spectrum*. 2003;16(3):184-187. doi:10.2337/diaspect.16.3.184.
22. Miller VA, Drotar D. Discrepancies between mother and adolescent perceptions of diabetes-related decision-making autonomy and their relationship to diabetes-related conflict and adherence to treatment. *J Pediatr Psychol*. 2003;28(4):265-274.
23. Anderson BJ, Brackett J, Ho J, Laffel LMB. An office-based intervention to maintain parent-adolescent teamwork in diabetes management: impact on parent involvement, family conflict, and subsequent glycemic control. *Diabetes Care*. 1999;22(5):713-721.
24. Hood KK, Butler DA, Anderson BJ, Laffel LMB. Updated and revised Diabetes Family Conflict Scale. *Diabetes Care*. 2007;30(7):1764-1769.
25. Williams LB, Laffel LMB, Hood KK. Diabetes-specific family conflict and psychological distress in paediatric type 1 diabetes. *Diabet Med*. 2009;26(9):908-914.
26. Wysocki T, Harris MA, Buckloh LM, et al. Randomized, controlled trial of Behavioral Family Systems Therapy for Diabetes: maintenance and generalization of effects on parent-adolescent communication. *Behav Ther*. 2008;39(1):33-46.
27. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol*. 1986;51(6):1173-1182.
28. Holmbeck GN. Post-hoc probing of significant moderational and mediational effects in studies of pediatric populations. *J Pediatr Psychol*. 2002;27(1):87-96.
29. Wiebe DJ, Berg CA, Korbel C, et al. Children's appraisals of maternal involvement in coping with diabetes: enhancing our understanding of adherence, metabolic control, and quality of life across adolescence. *J Pediatr Psychol*. 2005;30(2):167-178.
30. Hill-Briggs F, Gemmell L. Problem solving in diabetes self-management and control: a systematic review of the literature. *Diabetes Educ*. 2007;33(6):1032-1052.
31. Hood KK, Huestis S, Maher A, Butler D, Volkening L, Laffel LMB. Depressive symptoms in children and adolescents with type 1 diabetes: association with diabetes-specific characteristics. *Diabetes Care*. 2006;29(6):1389-1391.
32. Vesco AT, Anderson BJ, Laffel LMB, Dolan LM, Ingerski LM, Hood KK. Responsibility sharing between adolescents with type 1 diabetes and their caregivers: importance of adolescent perceptions on diabetes management and control. *J Pediatr Psychol*. 2010;35(10):1168-1177.
33. Phillip M, Battelino T, Rodriguez H, Danne T, Kaufman F; European Society for Paediatric Endocrinology; Lawson Wilkins Pediatric Endocrine Society; International Society for Pediatric and Adolescent Diabetes; American Diabetes Association; European Association for the Study of Diabetes. Use of insulin pump therapy in the pediatric age group: consensus statement. *Diabetes Care*. 2007;30(6):1653-1662.
34. Grey M, Boland EA, Davidson M, Yu C, Sullivan-Bolyai S, Tamborlane WV. Short-term effects of coping skills training as adjunct to intensive therapy in adolescents. *Diabetes Care*. 1998;21(6):902-908.