

The Effects of Multisystemic Therapy on Diabetes Stress Among Adolescents With Chronically Poorly Controlled Type 1 Diabetes: Findings From a Randomized, Controlled Trial

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ABSTRACT. *Objective.* The goal of this study was to determine whether multisystemic therapy (MST), an intensive, home-based psychotherapy, could decrease diabetes-related stress among adolescents with chronically poorly controlled type 1 diabetes. Stress was also evaluated as a mediator of the effect of MST on adherence and metabolic control.

Methods. A randomized, controlled trial was conducted with 127 adolescents with type 1 diabetes mellitus and chronically poor metabolic control (hemoglobin A1c levels of $\geq 8\%$ at study enrollment and for the past 1 year) who received their diabetes care in a children's hospital located in a major Midwestern city. Participants assigned randomly to MST received treatment for ~6 months. Data were collected at baseline and at a 7-month posttest (ie, treatment termination). Changes in diabetes-related stress, as measured with a self-report questionnaire, were assessed. Structural equation models were used to test the degree to which changes in stress levels mediated the ability of the MST intervention to improve adherence and metabolic control.

Results. In intent-to-treat analyses, participation in MST was associated with significant reductions in diabetes-related stress. Tests for moderation found no significant effects of age, gender, or ethnicity, which suggests that the intervention was equally effective in reducing diabetes stress for all participants. However, structural equation modeling did not provide support for diabetes stress as the mechanism through which MST improved health outcomes. Rather, the final model suggested that MST improved metabolic control through increased regimen adherence.

Conclusions. Intensive, home-based psychotherapy reduces diabetes-related stress among adolescents with chronically poorly controlled type 1 diabetes. Such stress reductions are important for the psychological well-being of a subset of youths with diabetes who are at high risk for future health complications. *Pediatrics* 2005; 116:e826–e832. URL: www.pediatrics.org/cgi/doi/10.1542/peds.2005-0638; *multisystemic therapy, diabetes mellitus type 1*.

ABBREVIATIONS. MST, multisystemic therapy; CPMC, chronically poor metabolic control; HbA1c, hemoglobin A1c.

Adolescents with type 1 diabetes mellitus face a number of stressors and challenges as a result of their chronic illness.^{1–4} These include the need to manage a complex medical condition that requires daily completion of multiple self-care behaviors, the impact of diabetes on social interactions with family members, peers, and teachers, and the interference of symptoms such as hypoglycemia with daily activities.

Previous studies investigated the impact of stress on health outcomes among persons with type 1 diabetes. The effects of stress on regimen adherence and metabolic control have been of particular interest. Stress has the potential to affect metabolic control directly through its impact on cortisol and other catabolic hormones that interfere with insulin metabolism. It may also affect metabolic control indirectly, by interfering with completion of self-care tasks. However, prior findings have been mixed, with some studies supporting a direct relationship between stress and metabolic control, some suggesting that adherence mediates the relationship between stress and metabolic control, and others showing no relationship.^{5–9} More recent work also suggests that such inconsistent findings may be attributable to the significant variability that exists among individuals in the degree to which stress affects blood glucose levels.^{10,11}

Because many studies have found links between stress and diabetes health outcomes, several intervention trials have used stress reduction as a means for improving adherence and/or metabolic control among adolescents with type 1 diabetes.^{12–14} These trials were similar in their use of group therapy rather than family therapy and their use of cognitive-behavioral techniques to reduce stress. Although all showed reductions in levels of adolescent-reported stress, only 1 study found improvements in self-reported adherence after completion of the intervention and none reported improvements in metabolic control. However, in only 1 of these studies were participants recruited on the basis of difficulties with adherence behavior or poor glycemic control. Therefore, opportunities to show improvements in these domains might have been limited.

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Recently our research group investigated the effectiveness of multisystemic therapy (MST) for the treatment of adolescents with chronically poorly controlled type 1 diabetes. MST is an intensive, home- and community-based, family therapy used originally with youths presenting with serious mental health problems and their families.¹⁵ Adolescents with chronically poor metabolic control (CPMC) and their families are characterized by high rates of psychiatric comorbidity, family psychopathologic conditions, and poor interactions with health care providers.^{16–21} The MST approach is an excellent fit with the known causes of CPMC, because the scope of MST interventions encompasses the individual adolescent, the family system, and the broader community systems within which the family operates (ie, school and health care system). Results of our prior studies showed MST to be effective in improving regimen adherence and metabolic control and decreasing hospital admissions in this population.^{22–24}

The purposes of the present study were to determine the effectiveness of the MST intervention in reducing adolescent stress related to diabetes and to investigate whether participant characteristics such as age, gender, and ethnicity were related to the success of MST in reducing stress. The primary targets of the intervention were family and extrafamily barriers to good adherence (eg, low levels of parental monitoring of diabetes self-care tasks and support for completion of self-care tasks or negative family interactions regarding diabetes care). Therefore, it was of interest to determine whether an individual-level outcome, ie, the adolescent's own stress related to diabetes, was reduced as a result of participation in MST. A secondary purpose was to clarify whether any reductions in diabetes stress would account for (function as a mediator of) the MST intervention's effect on adherence and metabolic control. It is relatively uncommon in the pediatric literature for behavioral intervention research to investigate the mechanisms of change, that is, why the intervention worked. However, pediatric intervention researchers have emphasized the need for studies that help specify the elements and processes of behavioral therapy that are the most important for effective child and family treatment.²⁵ It was predicted that adolescents receiving MST would have reductions in diabetes-related stress, compared with control subjects. In addition, it was predicted that diabetes stress would mediate the effects of MST on both adherence and metabolic control.

METHODS

Participants

Adolescents and their families were participants in a larger clinical trial investigating the effectiveness of MST for improving health outcomes among adolescents with chronically poorly controlled type 1 diabetes.²⁴ They were recruited in the period between 1999 and 2004, from an endocrinology clinic within a tertiary care children's hospital located in a major Midwestern metropolitan area. Inclusion criteria were as follows: (1) diagnosed as having type 1 diabetes for ≥ 1 year, (2) CPMC, as defined by an average glycohemoglobin (hemoglobin A1c [HbA1c]) level of $\geq 8\%$ during the year before study entry, as well as a most recent HbA1c level of $\geq 8\%$, (3) between 10 and 17 years of age,

and (4) sufficient mastery of English to communicate with therapists and to complete study measures. The only study exclusion criteria were moderate or severe mental retardation and psychosis. The research was approved by the human investigation committee of the university affiliated with the hospital where the adolescents received medical care. All participants provided informed consent to participate.

Of the 182 families eligible for participation, 33 families (18%) refused to participate. Five families (3%) indicated an interest in participating but asked to be recontacted later, and 17 families (9%) consented to participate but had not completed baseline data collection when study enrollment was closed and were not assigned randomly. The final sample consisted of 127 adolescents and their families (70% of eligible families). Sixty-four participants were assigned to MST and 63 to the control condition. Nine (7%) of the 127 families dropped out of the study before completing follow-up data collection, and another 8 (6%) did not complete data collection within the specified window (87% completion rate). Seven of the 17 families were in the MST group and 10 were in the control group; there was no suggestion of differential loss to follow-up monitoring between the groups.

The study was a randomized, controlled trial with a repeated-measures design. Families assigned randomly to MST received ~6 months of home-based psychotherapy plus standard medical care, whereas families assigned randomly to the control condition received standard care only. Random assignment to treatment group was completed after baseline data collection. To ensure equivalence across treatment conditions, random assignment was stratified according to the HbA1c level at the baseline visit. Data were collected 7 months after baseline data collection.

Intervention Condition

Adolescents assigned to the intervention condition received MST plus standard medical care (described below). MST is an intensive, family-centered, community-based treatment originally designed for use with adolescents presenting with serious antisocial behavior.^{26,27} Because MST is designed to target the multiple systems within which youths with serious problems and their families are embedded, it does not follow a session-by-session treatment protocol. Rather, MST is specified through 9 treatment principles that operationalize the parameters for designing and implementing interventions and a treatment manual focusing on the application of these principles. To promote treatment fidelity, therapists and their supervisor received formal, 1-week training in MST techniques. MST interventions were monitored for treatment fidelity with state-of-the-art quality assurance protocols, including weekly on-site clinical supervision, weekly telephone consultation with an MST expert consultant, quarterly booster training, and feedback from formal fidelity ratings.^{28,29} Therapists began by conducting a multisystemic assessment of the strengths and weaknesses of the family and then, on the basis of this assessment, tailored treatment goals and interventions to each family to treat the adherence problem most effectively. Details of procedures to establish MST treatment fidelity, as well as data showing associations between fidelity to the MST approach and improved clinical outcomes, have been reported extensively elsewhere.^{30–32}

In the current study, therapists were expected to meet with families a minimum of 2 or 3 times per week at the beginning of treatment. Treatment was terminated when treatment goals were met, rather than when a set number of sessions were completed. However, on the basis of previous MST trials and our own experience, treatment was planned to last ~6 months. The mean length of treatment in the study was in fact 5.7 months. Twenty-five percent of treatment families (16 of 64 families) did not complete a full course of therapy. The mean number of sessions was 48 (SD: 19 sessions) for treatment completers and 9 (SD: 8 sessions) for dropouts.

MST interventions targeted adherence-related problems within the family system, the peer network, and the broader community systems within which the family was embedded. Therapists drew on a menu of evidence-based intervention techniques, including cognitive-behavioral therapy, parent training, and behavioral family systems therapy. Family interventions focused on improving parental involvement, monitoring, and discipline regarding the adolescent's diabetes regimen, developing family organizational routines such as regular meal times, and teaching caregivers to communicate effectively with each other about the adolescent's

medical regimen. Peer interventions included enlisting the active support of peers regarding regimen adherence.

School interventions included improving family-school communication about the adolescent's diabetes care needs and adherence behaviors (eg, having school personnel report blood glucose readings from the school meter to parents each week) and working with school personnel to monitor and to support completion of the adolescent's regimen (eg, finding a private place to test blood glucose levels). At the community level, interventions included developing strategies to monitor and to promote the youth's diabetes care in school or other settings (eg, extracurricular activities or visiting extended-family members). Interventions within the health care system included helping the family resolve barriers to keeping appointments and working with the family and the diabetes treatment team to promote a positive working relationship. Routinely therapists accompanied families to their medical appointments.

Standard Care Control Condition

Adolescents assigned to the control condition received standard medical care. Standard care at the hospital where the adolescents were treated consisted of quarterly medical visits with a multidisciplinary medical team composed of an endocrinologist, a nurse, a dietician, a social worker, and a psychologist. Adolescents in the standard care group were not restricted from receiving mental health services such as outpatient psychotherapy or psychiatric management during study participation. However, only 3 adolescents assigned to the standard care condition were reported by their parents to have received such services during the study.

Measures

Adolescents completed the 54-item version of the Diabetes Stress Questionnaire.¹² The Diabetes Stress Questionnaire is a self-report instrument designed to measure day-to-day stressors encountered by adolescents when managing their diabetes. The instrument measures stress related to worries about diabetes, peer and family interactions, diabetes management responsibilities, and effects of symptoms such as hypoglycemia and hyperglycemia, on a scale of 1 to 4 points. A total stress score is obtained, with higher scores indicating higher levels of stress. For the present sample, internal consistency with coefficient α was .93. The measure has been shown to have good concurrent validity.¹²

Adherence to the regimen was measured as the frequency of blood glucose testing. Data were obtained directly from the adolescent's blood glucose meter, rather than through self-report, to obtain the most objective information possible. The frequency of testing during the 14-day period immediately preceding data collection was recorded, and an average daily testing frequency was calculated subsequently. Although diabetes self-care includes completion of insulin administration and management of diet, blood glucose testing is the regimen adherence behavior that has been linked most closely to metabolic control in pediatric populations.³³

For the majority of participants, HbA1c levels (reference range: 4–6.4%) were calculated by the medical center laboratory from total glycohemoglobin levels. This approach was used by the laboratory because of the high prevalence rate of abnormal hemoglobin variant carriers in the population served, which is primarily black. Total glycohemoglobin levels were analyzed through boronate affinity chromatography with a glycohemoglobin and protein analyzer (model CLC385; Primus Corp, Kansas City, MO). However, 5.5% of HbA1c values were calculated during a medical appointment in the diabetes clinic, with a DCA 2000 system (Bayer, Elkhart, IN), which uses an immunoglobulin-agglutination method. DCA 2000 system results were used when adolescents were seen in a clinical appointment on the day of a research visit and refused venipuncture or when families missed the study visit but completed their clinical visit.

Statistical Analyses

The hypothesis that the MST group would have improved outcomes, relative to the standard care group, was tested with an intent-to-treat approach in which all randomly assigned participants were included. Noncompleters of the posttest data collection (7 subjects in the MST group and 10 in the control group) were treated conservatively as if no change occurred, and the partici-

part's baseline score for each outcome variable was forwarded to the follow-up point. A 2×2 (treatment \times time) mixed-design analysis of variance was conducted, with diabetes stress serving as the dependent variable. Treatment (MST or standard care) served as the between-subjects factor, and time (baseline to follow-up assessment) served as the within-subjects factor. The effect of interest was the treatment \times time interaction term. Basing the test on change from baseline scores improves the sensitivity of the analysis and controls for any potential baseline differences between groups. To test for moderators of treatment effects, age, gender, and ethnicity were then added separately as factors. Age was transformed into a categorical variable with 2 levels based on a median split with respect to age, and ethnicity was transformed into a categorical variable with 2 levels (black and other) because children in the study were primarily of either black or white ethnicity (Table 1). The 3-way interaction (eg, treatment \times time \times age) was then tested for significance at conventional levels (2-tailed $\alpha = .05$) with analysis of variance.

The hypothesis that diabetes stress would function as a mediator of improvements in regimen adherence and metabolic control was tested through structural equation modeling with Amos software, version 5.0 (SPSS, Chicago, IL). A maximum-likelihood solution was used to analyze the covariance matrix of the variables. Structural equation modeling was considered more appropriate than traditional multivariate analyses for testing mediation because it allows both the assessment of goodness of fit of a specified model and the testing of each estimated path coefficient.³⁴ Figure 1 shows the conceptual model tested through structural equation modeling. The direct effects of stress on adherence and HbA1c levels were included in the theoretical model, as was an indirect effect of stress on HbA1c levels through adherence.

RESULTS

Sample characteristics are presented in Table 1. Consistent with the demographic features of the population of the clinic where participants were recruited and the known over-representation of minorities among the population of adolescents with CPMC, 63% of the sample was black. The mean HbA1c level of adolescents at study entry was 11.3% (SD: 2.3%), which confirmed that adolescents in the sample had poor metabolic control. The majority of the adolescents who participated in the study were

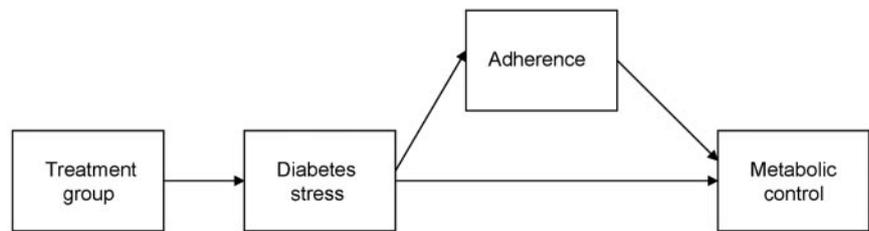
TABLE 1. Demographic Characteristics of Adolescents and Their Families (MST Versus Standard Care)

	MST	Standard Care
No.	64	63
Child age, y	13.4 \pm 1.9	13.1 \pm 2.0
Parent age, y	39.7 \pm 7.7	37.9 \pm 5.9
Annual family income, dollars	28 437 \pm 18 617	27 468 \pm 17 285
Child gender, no. (%)		
Male	38 (59)	24 (38)
Female	26 (41)	39 (62)
Parents in home, no. (%)		
Two parents*	36 (57)	33 (52)
Single parent	27 (41)	27 (43)
Other/missing	1 (2)	3 (5)
Child ethnicity, no. (%)		
Black	44 (69)	36 (57)
White	13 (20)	20 (32)
Other	7 (11)	7 (11)
Duration of diabetes, y	5.3 \pm 3.9	5.2 \pm 4.8
HbA1c, %	11.4 \pm 2.2	11.3 \pm 2.3
Insulin regimen, no. (%)		
2 or 3 injections per d	56 (88)	58 (92)
\geq 4 injections per d	2 (3)	1 (2)
Insulin pump	6 (9)	4 (6)

Data are means \pm SD or number (%).

* Two parents included 2 biological parents, a biological parent and a step-parent, or a biological parent living with a partner.

Fig 1. Conceptual model tested through structural equation modeling.



treated with injected insulin, whereas 8% used an insulin pump. Comparability between the 2 treatment conditions at baseline was tested by using Student's *t* test for continuous variables and Fisher's exact test for categorical variables. There were no significant differences between the MST and control groups in study entry HbA1c levels or in the majority of demographic variables, such as duration of diabetes, regimen type, child and parent ages, family composition, ethnicity, and income (Table 1). However, significantly more male subjects were randomly assigned to the MST group.

Results of the analysis of variance showed a significant treatment-time interaction for diabetes stress (Fig 2). Adolescents who received MST had significantly reduced levels of stress from baseline (mean score: 59.6; SD: 29.5) to the 7-month follow-up assessment (mean score: 51.9; SD: 29.8), compared with those in the control group, for whom stress levels increased from baseline (mean score: 57.4; SD: 25.9) to the follow-up assessment (mean score: 61.8; SD: 26.7) [$F(1,125) = 8.55; P = .004$]. Tests for moderation showed no significant 3-way interactions for age [$F(1,123) = 0.19; P = .66$], gender [$F(1,123) = 0.66; P = .42$], or ethnicity [$F(1,123) = 0.69; P = .41$]. This suggests that the intervention was equally effective in reducing diabetes stress for both younger and older adolescents, male and female adolescents, and adolescents of black and other ethnicity.

Univariate correlations between baseline and follow-up diabetes stress, adherence, and metabolic control and baseline demographic variables tested as moderators of treatment effects are shown in Table 2. At baseline, diabetes stress was related significantly to metabolic control ($r = 0.26; P < .01$) but not to adherence, age, gender, or ethnicity. At the follow-up assessment, diabetes stress was related significantly to metabolic control ($r = 0.24; P < .01$) and gender ($r = -0.22; P < .05$), with girls reporting

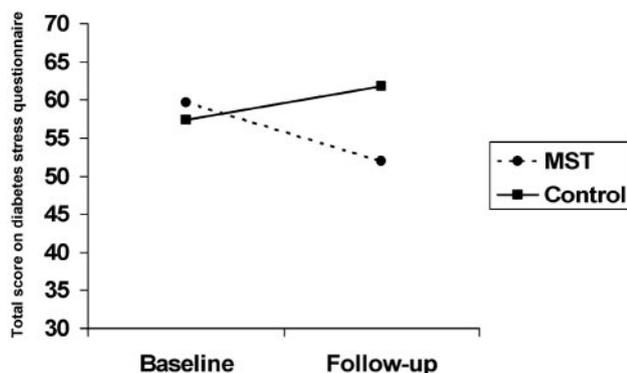


Fig 2. Diabetes Stress Questionnaire scores.

higher stress. No other significant relationships were found. The relationship between baseline stress and other demographic variables was also examined. Significant relationships were found between baseline diabetes stress and number of parents in the home ($r = 0.23; P < .05$) but not family income or duration of diabetes. No significant relationships were found between diabetes stress at follow-up assessment and these additional demographic variables.

In structural equation modeling analyses, the theoretical model shown in Fig 1 was tested first. Paths from each baseline variable to the corresponding variable at the 7-month follow-up assessment (time 2) were added to adjust for initial (baseline) status. A recursive model involving only observed variables and latent uncorrelated residuals was tested, with 7 exogenous variables, 2 mediators (time 2 adherence and time 2 diabetes stress), and 1 outcome (time 2 HbA1c level). Observed variables rather than latent variables were used in the path model because multiple measures of the constructs (ie, stress and adherence) were not available. The exogenous variables were of 3 types, ie, baseline scores (time 1 HbA1c level, time 1 adherence, and time 1 diabetes stress), the intervention group variable (group assignment), and covariates (adolescent race/ethnicity, gender, and age). Covariates were added to the model empirically after an analysis of residuals was performed. In this analysis, residual error for each endogenous construct was first computed by using regression. The pattern of correlation between each residual and each potential covariate was then examined. Covariates that were significantly related to the residuals were then added to the model. Finally, nonsignificant paths between exogenous variables were trimmed from the model.

Model fit statistics for the first model were inadequate, with a significant χ^2 [$\chi^2(29,127) = 42.15; P = .05$; comparative fit index: 0.96; root mean square error of approximation: 0.06]. Inspection of the modification indices showed a large modification index (modification index: 12.91) for the path between group assignment and adherence. Therefore, this path was freed and a second model was tested. Comparison of the 2 models through calculation of the difference χ^2 [$\chi^2(1) = 14.44; P = .001$] showed that the second model had a significantly better fit for the data.

The final path model is shown in Fig 3. For simplicity, baseline scores are labeled as time 1 and 7-month follow-up scores are labeled as time 2. The correlation matrix, standardized residuals, and other descriptive statistics are presented in Table 2. Multivariate normality was satisfactory, according to Mar-

TABLE 2. Correlation Matrix and Standardized Residuals From Structural Equation Model

Variable	1	2	3	4	5	6	7	8	9	10
1. Group	0.01	-0.56	0.20	0.69	0.51	0.20	0.13	0.86	-0.03	1.16
2. HbA1c, time 1	-0.02	0.06	0.24	-0.66	-1.36	0.30	0.14	2.20	0.28	-0.15
3. HbA1c, time 2	0.08	0.75*	0.29	-0.02	-0.99	0.04	0.37	1.68	-0.47	-0.22
4. TPD, time 1	0.12	-0.29*	-0.24*	0.27	0.15	-0.35	-1.10	-0.61	-2.41	0.01
5. TPD, time 2	-0.19†	-0.26*	-0.33*	0.59*	0.01	-0.88	-0.86	-0.14	-1.89	0.18
6. Stress, time 1	-0.04	0.26*	0.22†	-0.12	-0.13	0.01	0.14	1.18	-0.93	-1.12
7. Stress, time 2	0.17	0.17	0.24*	-0.14	-0.17	0.64	0.14	1.25	-0.60	-1.04
8. Age	-0.08	0.20†	0.20†	-0.35*	-0.36*	0.10	0.11	0.01	1.13	0.29
9. Gender	-0.21†	0.02	-0.06	-0.21†	-0.11	-0.08	-0.22†	0.10	0.01	-0.24
10. Race	0.10	-0.29*	-0.34*	0.00	0.02	-0.10	-0.09	0.03	0.28*	0.01
SD	0.50	2.29	2.48	1.24	1.41	27.68	28.61	1.95	0.50	0.49

Correlations among model variables are below the diagonal, standardized residuals are on and above the diagonal, and SDs are in the bottom row. Group (MST = 1, control = 2), tests per day (TPD), gender (1 = female, 2 = male), and race (1 = black, 2 = white) were tested.

* $P < .01$.

† $P < .05$.

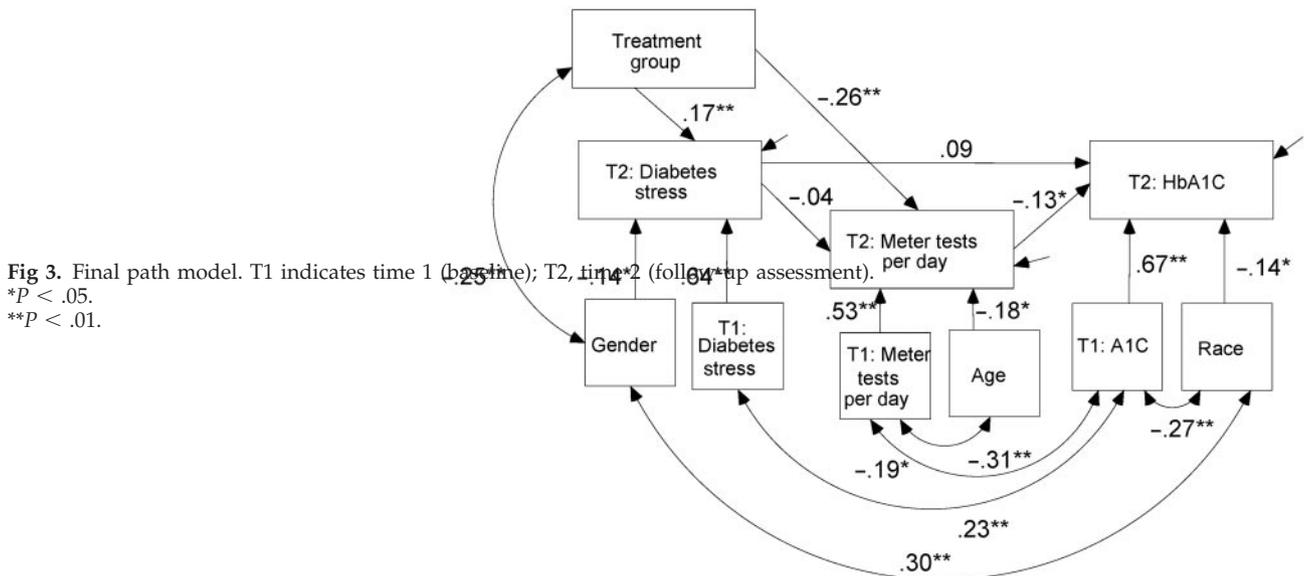


Fig 3. Final path model. T1 indicates time 1 (baseline); T2, time 2 (follow-up assessment).
* $P < .05$.
** $P < .01$.

dia's coefficient ($P > .05$).³⁵ The overall fit of the model was excellent [$\chi^2(28,127) = 27.71$; $P = .48$; comparative fit index: 1.0; root mean square error of approximation: 0.001]. Good fit to the data was also indicated by the fact that all except 2 standardized residuals had a value of <2 . The model indicates that the MST intervention had significant direct effects on diabetes stress and on adherence. However, there was no support for a specific indirect, or mediated, effect of stress on adherence. In addition, once a path between adherence and metabolic control was included, there was no support for a mediated effect of stress on HbA1c levels. Rather, adherence and HbA1c levels were significantly related, with increased adherence resulting in improved metabolic control. Bootstrap significance testing was conducted to determine whether the indirect effect of MST on HbA1c levels was significant; this test indicated that the effect was significant at $P = .012$. Improvements in HbA1c levels can be attributed primarily to the specific indirect effect of MST on HbA1c levels through adherence, which makes up 67% of the total indirect effect.

DISCUSSION

Investigation of stress among adolescents with type 1 diabetes is important to identify the direct and indirect pathways through which stress affects behavioral and health-related outcomes in this population. The primary purpose of the present study was to determine whether MST, an intensive, home-based, psychotherapy intervention, could reduce diabetes-related stress among adolescents with type 1 diabetes and CPMC. Because our prior work showed that MST improved regimen adherence and metabolic control and because stress reductions were targeted in prior intervention studies as a means of improving adherence among adolescents with diabetes, a second purpose was to determine whether stress would function as a mediator of the effects of MST on regimen adherence and metabolic control. Our findings indicated a significant reduction in diabetes stress for adolescents assigned to the MST group, compared with those who received standard care, for whom stress increased over time. This finding is consistent with the reduction in stress reported in previous intervention studies with adoles-

cents.¹²⁻¹⁴ Although MST intervenes much more broadly than the individual-focused interventions reported in those studies, all interventions taught diabetes management and problem-solving skills. This may be one way in which the "stressfulness" of diabetes was reduced. However, previous studies did not attempt to change family relationships regarding diabetes care and did not intervene directly in the peer system or target relationships with health care providers. Poor family and provider relationships are characteristic of adolescents with CPMC.¹⁸⁻²¹ Accordingly, interventions that are limited in scope may not be sufficient to affect diabetes-related stress among adolescents with CPMC.

In addition, the MST intervention was effective in reducing stress regardless of the age, gender, and ethnicity of the participants. Previous intervention research was conducted with primarily white, middle-class samples and therefore did not address the needs of minority and/or low-income adolescents with diabetes. This is an important gap in the literature, because minority subjects are more likely to suffer from CPMC^{36,37} and minority adolescents with chronic illnesses have increased rates of stress, compared with nonminority subjects.³⁸ Gender was not addressed in previous intervention studies, although adolescent female subjects with diabetes tend to report higher levels of diabetes-related stress than do adolescent male subjects.⁸ This study represents one of the very few trials to investigate these critical variables as potential moderators of treatment outcomes.

For better understanding of the processes through which MST exerted its effects, it was also hypothesized that stress would mediate the effects of MST on adherence and metabolic control. However, this hypothesis was not supported. Although stress was related to metabolic control and metabolic control did improve in the MST group, the improvement was attributable to an increase in the frequency of blood glucose testing and not reductions in stress. Similarly, the data did not support the hypothesis that reductions in stress were responsible for improved adherence in the MST group. Rather, MST had a direct effect on adherence behavior. Such findings may illustrate why prior intervention studies that attempted to improve metabolic control through stress reduction failed to find such effects; unless adolescents with high levels of glycemic instability in the presence of stress are targeted for stress-reducing interventions, direct targeting of adherence behavior may be a more efficient means of reducing blood glucose levels. Nevertheless, the reduction of stress in the present sample might have had positive effects on other aspects of adolescent adjustment, such as psychological well-being and emotional functioning. It is also possible that diabetes stress, measured with a self-report scale, may be a better indicator of more subjective health outcomes, such as quality of life. It will be important to investigate such links in future research.

Limitations of the present study include the use of a standard care control group, as opposed to an attention control group. It is possible that the degree

of intervention intensity, as opposed to the specific content of the intervention, was responsible for decreases in stress and improvements in adherence and metabolic control. Other limitations include the measurement of only a single aspect of regimen adherence (blood glucose testing). This measure was chosen because of its close association with metabolic control in prior studies.³³ However, it is possible that diabetes stress was related more strongly to other aspects of regimen adherence, such as insulin administration, diet, or exercise. It is also important to note that the present study reports only on outcomes at the 7-month posttest, which occurred at treatment termination. Additional follow-up monitoring of the sample is needed to assess the stability of these stress reductions and to determine whether long-term reductions in stress ultimately might affect regimen adherence or metabolic control.

CONCLUSIONS

Results of the present study support the effectiveness of intensive, home-based, family therapy in reducing diabetes stress among adolescents with type 1 diabetes and CPMC. Such stress reductions may be important in improving the psychological well-being and quality of life of a subset of youths with diabetes who are at high risk for future health complications.

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