Empirically Derived Patterns of Perceived Stress Among Youth With Type 1 Diabetes and Relationships to Metabolic Control

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Objective Given the inconsistent relationship between stress and metabolic control, the purpose of this study was to empirically derive patterns of perceived diabetes-related stress among youth with type 1 diabetes mellitus (T1DM) and determine if these patterns relate to overall diabetes-related stress levels and metabolic control.

Method A sample of 204 youth with T1DM completed the diabetes stress questionnaire, and their hemoglobin A1c (a long-term measure of metabolic control) was obtained from their medical record.

Results Latent profile analyses revealed three perceived-stress profiles: “low stress” (LS), “interpersonal/peer” (IP), and “family stress” (FS). The FS and IP groups reported more overall stress than the LS group; however, only the FS group’s HbA1c values were significantly higher than either the LS or IP groups.

Conclusions A global measure of stress may not accurately account for the association between perceived stress and metabolic control. FS, rather than IP stress seems to be a key stress domain linked to suboptimal metabolic control.

Key words latent profile analysis; metabolic control; stress; type 1 diabetes.

Results from the Diabetes Control and Complications Trial (DCCT) indicated that hemoglobin A1c (HbA1c; a long-term measure of metabolic control) levels of <7% are associated with a reduction in the incidence of the complications associated with diabetes, such as nephropathy, retinopathy, neuropathy, heart disease, and stroke (DCCT, 1994). Optimal metabolic control is accomplished by balancing a range of activities, including diet, exercise, and medication administration. However, adolescents have been shown to experience increased difficulty with regimen adherence, higher levels of perceived stress, and poorer HbA1c values than other age groups (DCCT, 1994).

Metabolic control of type 1 diabetes mellitus (T1DM) often declines during adolescence, and stress is thought to play an important role in this process (Johnson, 1995). Among youth with T1DM, stress (i.e., perceived or experienced distress in response to situations, events, or “stressors”) is associated with more general psychological distress, worse metabolic control, and poorer regimen adherence (Farrell, Hains, Davies, Smith, & Parton, 2004; Helgeson, Escobar, Siminerio, & Becker, 2010). Conceptually, stress may affect metabolic control in adolescents with diabetes in a number of ways. Stress may affect metabolic control directly through the physiologic changes that occur within the body under stress (e.g., by increasing hepatic glycogen production and insulin resistance; Mortensen et al., 1998) and indirectly by interfering with an individual’s ability to adhere to diabetes regimens (Johnson, 1995; Helgeson et al., 2010; Hoffman, 2002).

Despite the conceptual linkages, the relationship between stress and metabolic control is inconsistent across studies and methodologies. A recent review suggested the strength and direction of the relationship between perceived stress and metabolic control varies significantly between individuals (Kramer, Ledolter, Manos, & Bayless, 2000). The implication of this variation is that stress may not always adversely affect all individuals’
metabolic control, but that it may have a weak, positive, and/or negative association with individuals’ blood glucose levels (Kramer et al., 2000). Based on this, stress may cue some individuals to engage in behaviors associated with optimal diabetes management (e.g., checking blood glucose more frequently; Blonde & Carter, 2005). Conversely, stress may cue others to engage in behaviors, such as avoiding diabetes care, which may lead to suboptimal management and metabolic control. The social–ecological context of stresses and stressors is believed to influence the extent to which stress affects metabolic control; however, many studies examine diabetes-related stress in general without taking context into account (Berlin et al., 2006).

Stress, stress processing, and the social–ecological context of these factors likely interact in complex ways in the prediction of metabolic control (Johnson, 1995; Gonder-Frederick, Cox, & Ritterband, 2002). The inconsistent relationship between stress and metabolic control is not surprising when one considers this relationship from a social–ecological/systems-oriented approach (Steele & Aylward, 2009) in conjunction with Wallander and Varri’s (1998) stress and coping model. Based on this model, the extent to which stress affects youths’ physical and social adjustment depends on a youth’s stress processing (which includes perceptions of stress and coping), and potentially the sources or ecological contexts of stress (e.g., family environment, social support, school environments, and peers). This combined perspective acknowledges that an individual’s development may be differentially affected by a number of factors, including psychological, familial, social, and environmental factors. Thus, perceived stress in different domains in an adolescent’s life may (or may not) affect the relationship between stress and diabetes health, and each stressor may affect health differently.

The majority of studies examining the relationship between different types of social–ecological stressors and metabolic control either investigate stressors in isolation or do not use statistical techniques that allow for the emergence of empirically derived patterns of perceived stressors (see review in Gonder-Frederick et al, 2002). Without allowing for the natural individual variation across different sources of perceived stress, results may be limited by researcher intuition of relevant stressor patterns and an accurate understanding of the relevant patterns of elevations in perceived stress may not be achieved. Taken together, a possible explanation for the inconsistent relationship between stress and metabolic control in adolescents is that this relationship varies according to the type, pattern, and/or social–ecological context of perceived stress. Often, studies have examined diabetes-related stress in general without examining associations between different patterns of perceived stressors and metabolic control. As such, identifying patterns of perceived stress/distress in adolescents with type 1 diabetes and the possible differential associations between different sources of perceived stress and metabolic control will allow physicians and behavioral health professionals to identify adolescents exhibiting at-risk patterns of perceived stress. This may also potentially indicate more strategic interventions targeting the socio-ecological context of the perceived stress (e.g., family therapy, school-based counseling, social skills/assertiveness training, and individual cognitive–behavioral approaches). Additionally, using analytical techniques that empirically derive different perceived stress patterns will help to identify the natural boundaries between different patterns of perceived socio-ecological stressors.

Therefore, the objectives of the present study were as follows: (a) to establish empirically derived patterns of diabetes-related stress among youth with T1DM; and (b) to determine if and how these patterns relate to overall perceived diabetes-related stress and metabolic control as measured by HbA1c. In accordance with the diabetes social information processing (Hains et al., 2006, 2007; Hains, Berlin, Davies, Parton, & Alemzadah, 2009) and diabetes family/stress literatures (Lewin et al., 2006; Viner, McGrath, & Trudinger, 1996), it was anticipated that approximately three patterns (or perceived stress profiles) would emerge (likely involving family and/or peers most prominently). It was hypothesized that a stronger positive relationship between metabolic control and overall perceived stress levels would be found among groups with higher perceived stress, relative to those reporting less perceived stress.

Method
Participants and Procedure

Archival data from 204 youth with TD1M (52% female; aged 10–18 years, M = 13.91 years, SD = 1.97) who participated in one of the two Institutional Review Board approved studies on peer attributions, stress, and T1DM (Hains et al., 2006, 2007, 2009). Data were collected in approximately 2002–2003, and 2004–2005, with guardian consent and youth’s assent. The mean HbA1c level for the participating youths was comparable to the mean for the clinic as a whole (8.7%). Approximately 83% of the youths who consented to participate, returned to complete the associated instruments. The aim of the larger studies was to test a social information processing model in which negative expectations of others’ reactions to diabetes care would predict anticipated adherence difficulties, and in turn, predict the
Diabetes Stress

The DSQ is a 65-item self-report instrument designed to assess perceived stress related to diabetes in adolescents. Youth rated the extent to which a variety of situations are stressful or a “hassle” using a 4-point scale ranging from “not at all” to “very much.” Conceptually, these scores assess stressors that have exceeded the youth’s coping resources (i.e., the stressors believed to affect metabolic control). The internal consistency has been reported to be excellent (Cronbach’s α = .97), and the measure has also been shown to have good reliability and criterion-related validity (Boardway, Delamater, Tomakowsky, & Gutai, 1993). The DSQ yields a total score with higher scores representing higher levels of perceived diabetes-related stress. The DSQ also has the following empirically derived subscales reflecting perceived stress in the named domains: distress-worry (e.g., “feeling like there is too much to do to keep my diabetes in good control”), peer stress (e.g., “testing my blood when my friends are with me”), adverse-interpersonal effects (e.g., “kids teasing me about diabetes”), parents/family (e.g., “parents criticizing me for not taking good care of my diabetes”), self-care regimen (e.g., “remembering to do all the things I have to do to take care of my diabetes”), diet (e.g., “ needing to eat when friends are not eating”), hyperglycemia (e.g., “getting symptoms of high blood sugar”), and hypoglycemia (e.g., “getting symptoms of low blood sugar like shakiness, sweating, hunger, or headache”). The DSQ items are averaged across subscales, and the DSQ total score is the average across all items. The internal consistencies of subscales used in this study ranged from α = .91–.72.

Metabolic Control

Metabolic control of the sample was assessed using hemoglobin A1c (HbA1c, M = 8.47, SD = 1.41, range: 5.4–14.0), which was obtained either during the clinic visit when recruitment took place or during the most recent clinic visit. HbA1c is commonly used as a measure of long-term blood glucose management and reflects the average level of blood glucose during a 2–3 month period. All samples were collected through DCA2000 (Bayer, Tarrytown, NY, USA) with the nondiabetic reference range between 4.5% and 5.7%. The mean HbA1c value for the combined samples was comparable with the mean for the clinic as a whole (M = 8.6).

Analytic Plan

Latent profile analyses (LPA) were conducted using Mplus 6.1 to establish empirically derived patterns (latent classes) of perceived diabetes-related stress among adolescents with T1DM (Muthén & Muthén, 2010). LPA is a multivariate statistical method of finding unobserved subtypes (latent classes) of individuals defined by the patterns of observed means from continuous indicators. LPA attempts to decrease heterogeneous data by probabilistically assigning individuals into more homogenous subgroups comprising individuals exhibiting similar patterns. As such, each individual is allowed fractional membership in all classes to reflect the latent nature (and uncertainty) of the class membership (Muthén, 2001). For this study, LPAs with correlated indicators were conducted to derive perceived diabetes-related stress patterns from the various DSQ subscales controlling for the potential confounding effects of gender, age, and time since diagnosis.

To determine the optimal number of classes, three statistical measures were used: Bayesian information criterion (BIC; Schwartz, 1978), the Lo–Mendell–Rubin test (LMR; Lo, Mendell, & Rubin, 2001), and the bootstrap likelihood ratio test (BLRT; McLachlan & Peel, 2000). The BIC compares non-nested models with different number of latent classes to evaluate model fit, with a lower BIC value signifying a better-fitting model. The LMR and BLRT tests compare the improvement between neighboring class models (i.e., comparing models with 2 vs. 3 classes, and 3 vs. 4 classes) and provide P-values that can be used to determine if there is a statistically significant improvement in fit for the inclusion of one more class (Nylund, Asparouhov, & Muthén, 2007). Entropy values (which range from 0.0 to 1.0) were also calculated as a measure of the accuracy of latent classification, with higher values indicating better classification.

To determine if and how these latent profiles relate to adolescents’ metabolic control, overall levels of diabetes-related stress, group differences in HbA1c, overall level of perceived diabetes stress (DSQ total score), and latent class indicators (i.e., the DSQ subscales) were assessed through pseudo-class draws (Asparouhov & Muthén, 2007) and the
Wald test/chi-square statistic (Asparohouv & Muthén, 2007; Wang, Brown, & Bandeen-Roche, 2005). Pseudo-class draws estimate class-specific means and variances; however, unlike analysis of variance (ANOVA), the estimates based on pseudo-class draws take into account differing individual probabilities of latent class membership, leading to less biased standard errors and tests of significance (Wang et al., 2005). Means and variances are estimated by taking random samples in which individuals are given the chance to be assigned into neighboring classes (consistent with each individual’s varying probabilities and thus, retaining the latent nature of class membership). Hedge’s g was calculated (using the means and standard errors estimated via pseudo-class draws) as a standardized mean difference effect size, which corrects for an upward bias when sample sizes are <20 (Hedges, 1981). For Hedge’s g, effect sizes equal to 0.2, 0.5, and 0.8 are considered small, medium, and large, respectively. Adjustments were made to α-level for multiple comparisons.

Table I. Latent Profile Analyses to Determine the Number of Classes

<table>
<thead>
<tr>
<th>Class(es) per model</th>
<th>Bayesian Information Criterion</th>
<th>Entropy</th>
<th>Bootstrap Likelihood ratio test</th>
<th>P value for Lo-Mendell-Rubin test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,653.113</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>2,640.552</td>
<td>0.915</td>
<td>.0389</td>
<td>&lt; .0001 (1 vs. 2 classes)</td>
</tr>
<tr>
<td>3</td>
<td>2,632.526</td>
<td>0.941</td>
<td>.0389</td>
<td>&lt; .0001 (2 vs. 3 classes)</td>
</tr>
<tr>
<td>4</td>
<td>2,657.637</td>
<td>0.896</td>
<td>.035</td>
<td>.05 (3 vs. 4 classes)</td>
</tr>
<tr>
<td>5</td>
<td>2,657.727</td>
<td>0.914</td>
<td>.001</td>
<td>.01 (4 vs. 5 classes)</td>
</tr>
<tr>
<td>6</td>
<td>2,677.862</td>
<td>0.924</td>
<td>.002</td>
<td>.02 (5 vs. 6 classes)</td>
</tr>
</tbody>
</table>

Note. Different superscripts indicate significant mean differences at p < .05/8 = .00625 (to control for multiple comparisons).

Results

Empirically Derived Patterns of Diabetes-Related Stress

Several latent profile models were examined, with each model specifying a different number of classes (one through six). The results presented in Table I suggested that the three-class model was the most optimal number of classes/patterns based on the BIC, entropy analyses, and LMR. The BLRT results suggested that models specifying more than three classes provided some statistical improvement in model fit; however, on inspection, these classes seemed to be slight (and smaller sized) variants of the three-class model. Therefore, the three-class model was chosen as the final model. Table II presents the descriptive and inferential (comparison) statistics of the three latent profiles’ DSQ scales (including internal consistencies), and demographic characteristics. As can be seen in Table II, the three subscales that best differentiated the classes (see comparisons) were perceived stress related to peers, adverse interpersonal effects, and parents/family.

The overall patterns of diabetes-related stress that emerged from the three-class model are as follows: LS characterized by low levels of perceived stress across most stress domains (n = 134, 67%); IP characterized by moderately high levels of perceived stress with the most influential domains related to PS, distress/worry, and adverse interpersonal effects subscales (n = 18, 9%); and FS characterized by the most influential stressors being interactions with the family and moderate levels of other perceived stress (n = 47, 24%). As anticipated from the covaried models, no significant differences were found...
across the classes in terms of demographic characteristics or illness duration (Table II). A graphical depiction of each groups’ DSQ scale means are presented in Figure 1.

As preliminary evidence of validity for the latent classes, Table III presents the average latent class probabilities for most likely latent class membership by latent class and statistical comparisons of these probabilities. Table III shows high rates of “correct” classification (98.7–93.9%) and low rates of misclassification (0.6–5.5%). Table III also reveals that the “inaccurate” classifications (the off-diagonal cells) do not statistically differ from one another as a function of class, suggesting that each class is correctly classified and has an equal probability of being “misclassified” into one of the other two classes.

Relationships Between Stress Profiles, Metabolic Control, and Overall Stress Levels

Significant and large mean differences were found based on latent class membership in overall diabetes-related stress [DSQ total; \( \chi^2 (2) = 110.47, P < .001 \)] with mean scores for the IP (\( M = 2.65, SD = 0.50 \)) and FS groups (\( M = 2.55, SD = 0.45 \)) statistically equal to each other [\( \chi^2 (1) = 0.57, P = .45, g = 0.22 \)], and both significantly higher than the LS group (\( M = 1.81, SD = 0.42 \)). [FS vs. LS: \( \chi^2 (1) = 100.29, P < .001, g = 1.75 \); IP vs. LS: \( \chi^2 (1) = 100.29, P < .001, g = 1.98 \)]. A different pattern emerged with regard to HbA1c means across latent classes. The mean HbA1c of the FS group (\( M = 9.47, SD = 1.72 \)) was significantly higher than that of the LS [\( M = 8.18, SD = 1.25; \chi^2 (1) = 21.54, P < .001, g = 0.93 \)] and IP groups [\( M = 8.18, SD = 1.32; \chi^2 (1) = 21.54, P < .001, g = 0.79 \)], which were not significantly different from one another [IP vs. LS: \( \chi^2 (1) = 0.00, P = .99, g = 0.002 \)]. To demonstrate potential variability in the strength and direction of the relationship between overall perceived

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Table III

<table>
<thead>
<tr>
<th>Most likely class</th>
<th>Low Stress (LS, ( n = 134 ))</th>
<th>Interpersonal/peer (IP, ( n = 47 ))</th>
<th>Family Stress (FS, ( n = 47 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Low stress</td>
<td>0.987* (0.05)</td>
<td>0.010* (0.05)</td>
<td></td>
</tr>
<tr>
<td>Interpersonal/peer</td>
<td>0.035* (0.05)</td>
<td>0.010* (0.05)</td>
<td>0.006* (0.01)</td>
</tr>
<tr>
<td>Family stress</td>
<td>0.018* (0.05)</td>
<td>0.01* (0.06)</td>
<td>0.967* (0.07)</td>
</tr>
</tbody>
</table>

Note. **Different superscripts indicate significant mean differences at \( p < .05 \)/9 = .005 (to control for multiple comparisons).

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Figure 1. Three diabetes-related stress profiles among youth with type 1 diabetes mellitus.
stress and HbA1c, the bivariate correlations between the DSQ total and HbA1c (LS: $r = 0.15$; IP: $r = 0.31$; FS: $r = 0.23$) were compared across the latent classes using equality constraints in multigroup path analysis. The IP group’s correlation was negative and significantly different from the positive correlations observed in the FS group [$\chi^2 (1) = 6.20$, $P = .01$] and the LS group [$\chi^2 (1) = 3.73$, $P = .05$]. No significant difference was found between the LS and FS groups’ correlation [$\chi^2 (1) = 0.69$, $P = .41$].

Table IV presents the descriptive statistics and correlations among the study variables for the total sample.

### Table IV: Descriptive Statistics (Mean ± Standard Deviation), and Correlations Among Study Variables for the Total Sample

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DSQ total</strong></td>
<td>2.06</td>
<td>.919**</td>
<td>.672**</td>
<td>1.74</td>
<td>1.95</td>
<td>2.25</td>
<td>2.25</td>
<td>1.99</td>
<td>2.02</td>
<td>13.91</td>
<td>(35.38 + 45.3)</td>
<td>8.47 + 1.41</td>
</tr>
<tr>
<td><strong>Worry</strong></td>
<td>.62</td>
<td>.854**</td>
<td>.595**</td>
<td>.762**</td>
<td>.649**</td>
<td>.762**</td>
<td>.649**</td>
<td>.595**</td>
<td>.649**</td>
<td>.693**</td>
<td>.693**</td>
<td>.595**</td>
</tr>
<tr>
<td><strong>Peers</strong></td>
<td>.62</td>
<td>.783**</td>
<td>.649**</td>
<td>.762**</td>
<td>.670**</td>
<td>.670**</td>
<td>.574**</td>
<td>.391**</td>
<td>.419**</td>
<td>.422**</td>
<td>.422**</td>
<td>.419**</td>
</tr>
<tr>
<td><strong>A.I.E.</strong></td>
<td>.62</td>
<td>.809**</td>
<td>.733**</td>
<td>.763**</td>
<td>.657**</td>
<td>.657**</td>
<td>.657**</td>
<td>.657**</td>
<td>.657**</td>
<td>.657**</td>
<td>.657**</td>
<td>.657**</td>
</tr>
<tr>
<td><strong>Parents/Family</strong></td>
<td>1.74</td>
<td>.819**</td>
<td>.733**</td>
<td>.763**</td>
<td>.733**</td>
<td>.763**</td>
<td>.733**</td>
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<td>.733**</td>
<td>.733**</td>
<td>.733**</td>
<td>.733**</td>
</tr>
<tr>
<td><strong>Hyper-glycemia</strong></td>
<td>.26</td>
<td>.721**</td>
<td>.657**</td>
<td>.657**</td>
<td>.657**</td>
<td>.657**</td>
<td>.657**</td>
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<td>.657**</td>
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<td>.657**</td>
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<tr>
<td><strong>Adherence</strong></td>
<td>.26</td>
<td>.672**</td>
<td>.564**</td>
<td>.564**</td>
<td>.564**</td>
<td>.564**</td>
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<tr>
<td><strong>Diet</strong></td>
<td>.26</td>
<td>.002</td>
<td>.008</td>
<td>.008</td>
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<td>.008</td>
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</tr>
<tr>
<td><strong>Hypo-glycemia</strong></td>
<td>.26</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
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<td>.02</td>
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<td>.02</td>
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<td>.02</td>
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<td>.02</td>
</tr>
<tr>
<td><strong>Age in Years</strong></td>
<td>.26</td>
<td>.073</td>
<td>.073</td>
<td>.073</td>
<td>.073</td>
<td>.073</td>
<td>.073</td>
<td>.073</td>
<td>.073</td>
<td>.073</td>
<td>.073</td>
<td>.073</td>
</tr>
<tr>
<td><strong>Illness Duration in Months</strong></td>
<td>.26</td>
<td>.282**</td>
<td>.282**</td>
<td>.282**</td>
<td>.282**</td>
<td>.282**</td>
<td>.282**</td>
<td>.282**</td>
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<td>.282**</td>
<td>.282**</td>
<td>.282**</td>
</tr>
<tr>
<td><strong>Hb1AC</strong></td>
<td>.26</td>
<td>.200**</td>
<td>.200**</td>
<td>.200**</td>
<td>.200**</td>
<td>.200**</td>
<td>.200**</td>
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<td>.200**</td>
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</tr>
</tbody>
</table>

Note. AIE = adverse interpersonal effects.

**p < .01, *p < .05.

Discussion

Given that the empirical literature has revealed an inconsistent relationship between stress and metabolic control in youth with T1DM, the primary purpose of this study was to determine whether various patterns of perceived stress or stress profiles exist and might account for inconsistencies in the relationship between perceived stress and metabolic control. To accomplish this objective, LPA determined that three empirically derived patterns (or profiles/classes) of perceived diabetes-related stress in youth with T1DM provided the most optimal fit to the data. These patterns were largely defined by minimal to moderate elevations across perceived stress, with or without family as the most prominent diabetes-related stress domain. More specifically, the most common pattern (67% of the sample) was the LS group, characterized by generally low levels of diabetes-related stress. The next most common group reported family as the most prominent stressor in the context of other perceived diabetes-related stress, which were moderately lower (FS, 24% of sample). The least common group (9%) was the IP group, which was characterized by a relatively high level of interpersonal and PS in the context of other moderately elevated perceptions of diabetes-related stress.

With regard to the overall level of perceived diabetes-related stress, large differences were found between the LS group and the two groups with elevated levels of stress (i.e., FS and IP stress groups). Although there was a small and nonsignificant difference in overall stress level between the FS and IP stress groups, the FS group had significantly higher mean HbA1c values compared with either the IP stress or LS group. The average HbA1c value of approximately 9.5% for the LS group in excess of the American Diabetes Association’s recommended HbA1c values for children 6–18 years of age of <7.5–8% (Silverstein et al., 2005), whereas the mean HbA1c values for the LS and IP stress groups were 8.2%, which is fairly consistent with the total and IP stress groups’ correlation [$R^2 (1) = 0.69$, $P = .41$]. No significant difference was found between the LS and FS groups’ correlation [$R^2 (1) = 0.69$, $P = .41$]. Table IV presents the descriptive statistics and correlations among the study variables for the total sample.
close to the recommended level. These results support previous findings indicating that family stress is closely associated with suboptimal metabolic control in adolescents with T1DM (Lewin et al., 2006). Furthermore, the results of the present study indicate that a global measure of perceived diabetes-related stress likely masks important contextual differences that may have implications regarding the short-term effects of poor metabolic control and may influence future vulnerability to diabetes-related complications. Clinicians and researchers may be mindful of the limitations of a global measure of diabetes-related stress and may seek to determine the extent to which various perceived stressors may overwhelm coping resources and possibly differentially impede effective diabetes management in clinical patients across multiple contexts.

These results are consistent with previous research linking family functioning and FS to metabolic control (Lewin et al., 2006; Viner et al., 1996). Given the previously demonstrated adverse effect of stress on metabolic control (Farrell et al., 2004; Helgeson et al., 2010), the nonsignificant difference between the mean HbA1c value for the IP stress group and that of the LS group was unexpected. A growing body of literature suggests that youth with T1DM who experience difficulties with peers may be a subgroup at particular risk for suboptimal metabolic control (Hains et al., 2006, 2007). The results here suggest that although there is a small subgroup of youth who report distress related to worry, peers, and adverse interpersonal events, they may not be at increased risk for elevated HbA1c levels. This finding is surprising and challenges previous work. These results may suggest that some stress, such as IP stress, may not have a negative impact on metabolic control. However, the results from the present study did not examine the impact that this type of perceived interpersonal stress has on quality of life, which has been related to poorer metabolic control over time for adults (Lloyd et al., 1999). Future studies might examine this type of perceived stress related to quality of life longitudinally. Additionally, IP stress might have to reach a specific threshold before affecting metabolic control. The present study did not directly sample individuals with high levels of stress in particular domains, but this might clarify the relationship between IP stress and metabolic control in future studies. Due to the relatively small number of participants in the IP stress group in the present study, it will be important to determine the extent to which these results can be replicated and generalized in larger samples.

Although the finding that family functioning is associated with poorer metabolic control in adolescents with type 1 diabetes is not a novel finding; the present study contributes to the current body of knowledge by presenting evidence of the differential relationship between various patterns of stress and metabolic control. The results also identified the IP stress group, which exhibited elevated perceived general diabetes-related stress, but membership was not associated with elevated mean HbA1c. Given results of the previous literature indicate that elevated negative interpersonal stress is related to the deterioration of metabolic control in adults over time (Lloyd et al., 1999), it is important that researchers and clinicians examine these psychosocial variables in addition to metabolic outcomes. The present study also examined the empirical organization of perceived stress, which is an approach not previously examined in this literature, and it is important for understanding the naturally occurring boundaries between different patterns of perceived stress and correlated health outcomes. Knowledge of the differential associations between patterns of perceived diabetes-related stress and metabolic control may inform the identification of adolescents at risk of poor metabolic control and may focus the efforts of practitioners in addressing the health consequences associated with metabolic dysfunction.

Given the exploratory nature of this study, it remains unclear how other important factors (e.g., family conflict/support, adherence, parental monitoring) play a role in either mediating or moderating these findings. For example, Lewin et al. (2006) found that adherence mediated the impact of family variables (e.g., parental warmth/caring, critical/negative parenting) on metabolic control, and Helgeson et al. (2009) found that positive family relations were related to better metabolic control for girls only. Future studies should further clarify the mechanisms by which (i.e., mediators) and the conditions under which (i.e., moderators) stress and metabolic control are related.

Some limitations of this study deserve comment. The small sample size of the IP stress group and the predominantly Caucasian racial/ethnic background of the sample, may limit the generalizability of the findings until future research can determine the robustness of these groupings and the impact of a more diverse sample. Second, no causal statements can be made regarding the directionality of the relationship between different patterns of perceived stress and metabolic control. For example, youth with poor metabolic control may evoke a parental response to increase their monitoring to encourage appropriate self-care, which the youth perceive as stressful. It should be emphasized that because of the cross-sectional design of the present study, the results do not rule out the possibility that patterns of perceived stress and conflict affect individuals differently over time. Further study should seek to identify the direction of causation and the longitudinal impact of different patterns of perceived stress. Another limitation is
that the study lacked a direct assessment of parent/child/family coping strategies, which may also moderate the relationship between stress and metabolic control.

In conclusion, perceived diabetes-related stress in youth with T1DM was effectively reduced to three empirically derived patterns, which were differentially related to overall perceived diabetes-related stress and metabolic control, with family stress seeming to be the most critical correlate of metabolic control.

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**References**


