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Longitudinal Trajectories of Parental Involvement in Type 1 Diabetes and Adolescents' Adherence

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Abstract

Objective—The purpose of this study was to examine longitudinal trajectories of parental involvement and adolescent adherence to the Type 1 diabetes regimen, to determine whether changes in multiple facets of parental involvement over time predicted subsequent changes in adolescents' adherence, and to examine whether adolescent self-efficacy mediated the effect of parental involvement on adherence.

Method—Two hundred fifty-two adolescents (M age = 12.49 years, SD = 1.53; 53.6% females) diagnosed with Type 1 diabetes mellitus, their mothers, and 188 fathers were enrolled in a 2.5-year longitudinal study. Across 5 time points, up to 252 adolescents and their parents completed measures of adherence, parental involvement (diabetes monitoring, behavioral involvement in diabetes management, and acceptance), and adolescent diabetes self-efficacy.

Results—Using multilevel modeling, analyses indicated significant average declines over time in adherence and most indicators of parental involvement. Lagged multilevel models indicated that declines in mothers' and fathers' acceptance and diabetes monitoring predicted subsequent declines in adolescents' adherence. Additional analyses revealed that longitudinal associations between both maternal acceptance and diabetes monitoring and subsequent adolescent adherence were mediated by adolescents' self-efficacy.

Conclusions—Results of this study, which were largely consistent across reporters, highlight the importance of maintaining parental involvement in diabetes across adolescence and suggest that parental involvement is beneficial for adolescents' adherence, in part, because it contributes to higher self-efficacy for diabetes management among adolescents.

Keywords

adolescents; adherence; diabetes; longitudinal; parental involvement

Managing Type 1 diabetes requires adherence to a multifaceted daily regimen involving blood glucose checks, insulin administration, adjustment of insulin dosage, and regulation of diet and exercise (American Diabetes Association, 2009). Adherence to the diabetes regimen is critical for the prevention of short-term health problems, including low blood-sugar and ketoacidosis, and long-term health complications, including kidney disease, retinopathy, and cardiovascular disease (Diabetes Control and Complications Trial Research Group, 1994; Hood, Peterson, Rohan, & Drotar, 2009). Adherence is particularly problematic during adolescence (e.g., Anderson, Auslander, Jung, Miller, & Santiago, 1990), due to the myriad biological, psychological, and social changes that occur during this developmental period (Bongers, Koot, van der Ende, & Verhulst, 2004; Gutman & Eccles, 2007).

Across adolescence, adherence deteriorates with age (Bryden et al., 2001; Johnson, Kelly, Henretta, & Cunningham, 1992; Morris et al., 1997), but reasons for this deterioration remain unclear, given a dearth of longitudinal research in this area and the problems with drawing conclusions about causality based on cross-sectional data. Cross-sectional studies in the diabetes literature (e.g., Anderson, Ho, Brackett, Finkelstein, & Laffel, 1997) and longitudinal research in the developmental literature (Larson, Richards, Moneta, Holmbeck, & Duckett, 1996) suggest that parental involvement in diabetes may decline during adolescence. The goal of this study was to use longitudinal data to examine whether deterioration in adolescents' adherence could be explained by declines in parental involvement in diabetes management. This study also examined whether longitudinal associations between parental involvement and adherence could be explained (i.e., mediated) by adolescents' diabetes self-efficacy (e.g., Berg et al., 2011).

In the context of Type 1 diabetes, the term "parental involvement" has not been well-defined and may refer to a number of parenting behaviors, including monitoring, support, responsibility for or assistance with diabetes management, warmth, and acceptance (e.g., La Greca & Bearman, 2002; Miller-Johnson et al., 1994). Using baseline data from the current study, and guided by previous work in the developmental and diabetes literatures (e.g., Ellis, Templin, Naar-King, & Frey, 2008; Dishion & McMahon, 1998), we investigated associations among multiple measures of parental involvement (Palmer et al., 2011). Structural equation modeling (SEM) identified three distinct components (i.e., latent factors) of parental involvement in the context of Type 1 diabetes: (a) behavioral involvement (assistance with management tasks), (b) monitoring (knowledge of adolescent's diabetes activities), and (c) relationship quality (warmth and acceptance). In a subsequent cross-sectional analysis utilizing these three facets of parental involvement, only maternal and paternal relationship quality and monitoring were uniquely associated with adherence (Berg

et al., 2011). Because the various indicators of parental involvement are correlated ($r_s = .23$ to $.79$; Palmer et al., 2011; Ellis et al., 2007), studies that examine multiple facets of parental involvement are needed in order to isolate unique effects of each aspect of parental involvement on adolescents' adherence.

There is a general consensus that parental involvement is beneficial for diabetes adherence among adolescents (Anderson et al., 1997; Berg, Butler, et al., 2008; Ellis et al., 2007; Wysocki & Gavin, 2006), at least cross-sectionally. In addition, some evidence suggests that longitudinal declines in parental involvement may be associated with declines in adolescents' adherence to the diabetes regimen. Helgeson, Reynolds, Siminerio, Escobar, and Becker (2008) found that teens who shared diabetes responsibilities with parents (i.e., behavioral involvement) displayed slower subsequent deterioration in blood glucose control, whereas teens who were independent in their diabetes responsibilities displayed more rapid deterioration. In addition, interventions designed to increase parents' behavioral involvement (e.g., increase parent-adolescent "teamwork") yielded subsequent improvements in diabetes outcomes (Grey, Davidson, Boland, & Tamborlane, 2001; Laffel et al., 2003). These studies suggest declining behavioral involvement from parents is associated with declining adherence during adolescence, but little is known about the contribution of other facets of parental involvement to declining adherence (e.g., parental monitoring, parental warmth, and emotional support).

The benefits of parental involvement for adolescents' adherence may occur because parents who are more involved aid in the development of adolescent self-efficacy (e.g., Berg et al., 2011). During adolescence, self-efficacy develops in the context of parents supporting adolescents' autonomy and being involved in their lives (Pomerantz, Grolnick, Price, Elliot, & Dweck, 2005). Self-efficacy, in turn, promotes better self-regulation and self-control (Keller, 2008), which may lead to better adherence (Bong, 2008). Our previous cross-sectional findings (using data collected at baseline) indicated that high relationship quality (i.e., high acceptance) with mothers and fathers was associated with better adherence through higher adolescent self-efficacy (Berg et al., 2011). In this study, we extended our previous research by examining whether the association between changes in parental involvement and subsequent changes in adolescent adherence was mediated by changes in adolescents' self-efficacy.

Much of the previous research on parents' involvement in Type 1 diabetes has been limited by a reliance on adolescent reports (Quittner, Espelage, Ievers-Landis, & Drotar, 2000), despite research showing that adolescents and parents do not always agree (Butner et al., 2009; McElhaney, Porter, Thompson, & Allen, 2008; Miller & Drotar, 2003; Tein, Roosa, & Michaels, 1994). Previous research has also been limited by a focus on maternal involvement. Although little is known about the contribution of fathers' involvement to adolescents' diabetes outcomes (Phares, Lopez, Fields, Kamboukos, & Duhig, 2005; Wysocki & Gavin, 2006), some studies have found fathers' involvement is linked with better adolescent diabetes outcomes (Berg, Butler, et al., 2008; Wysocki & Gavin, 2006), whereas fathers' uninvolvement is linked with poor outcomes (Harris, Greco, Wysocki, Elder-Danda, & White, 1999; Thompson, Auslander, & White, 2001).

The current study examined whether declines in adherence across adolescence (ages 10 to 17) could be tied to declines in parental involvement, and whether the association between changes in parental involvement and changes in adherence would be mediated by changes in adolescents' diabetes self-efficacy. Data were collected using multiple informants, so hypotheses about maternal and paternal involvement in diabetes management could be tested using adolescents', mothers', and fathers' reports. The first goal of the study was to examine whether there were longitudinal changes in parental involvement in diabetes management across adolescence. Declines were expected to occur in all facets of involvement, given normative pressures for parents to reduce their involvement (i.e., declines in monitoring, relationship quality, and behavioral involvement). The second goal was to examine changes in adherence across adolescence; it was anticipated that adolescents would show age-related declines in adherence. Third, longitudinal associations between parental involvement and adherence were examined. Declines in each aspect of parental involvement (monitoring, relationship quality, and behavioral involvement) were expected to predict declines in adherence. Finally, this study examined whether changes in self-efficacy mediated (at least partially) longitudinal associations between parental involvement and adherence.

Method

Participants

Participants included 252 adolescents (M age = 12.49 years, SD = 1.53; 53.6% females) diagnosed with Type 1 diabetes mellitus, their mothers, and 188 fathers recruited from a university/private partnership clinic (85%) and a community-based independent practice (15%) that followed similar treatment regimens and clinic procedures. To be eligible for the study, adolescents had to be between 10 and 14 years of age at study initiation, have diabetes for more than 1 year (M = 4.13 years, SD = 2.98), live with their mother, and be able to read and write either English or Spanish. At the beginning of the study, approximately half (50.8%) of adolescents were on an insulin pump, with the remainder prescribed multiple daily injections (MDI); by the end of the study (approximately 2.5 years later), 63% of adolescents were on an insulin pump. Mothers of adolescents on MDI reported that physicians recommended an average of 4.14 insulin injections (SD = 1.81, range = 0 to 10) and 5.53 blood glucose checks per day (SD = 1.70, range = 1 to 11).

Eligible families were approached for participation in the study during a visit to their diabetes clinic. Of the qualifying individuals approached, 66% agreed to participate in the study. Reasons for refusal included travel distance to laboratory (18%), too busy (21%), not interested (30%), uncomfortable with being studied (14%), and the time commitment involved in participation (5%). Most families were Caucasian (91.7%) and middle class; most (63.5%) reported household incomes averaging \$50,000 or more annually; 52.4% of mothers and 44% of fathers reported education levels of 2 years of college or beyond; an average Hollingshead index value of 41.19 indicated a medium business, minor professional, technical status.

Procedure

This study was approved by the institutional review board. Before participating, parents gave written informed consent and adolescents gave written assent. Families completed assessments every 6 months for a period of 2.5 years. At each assessment, adolescents completed a set of questionnaires at home, and additional questionnaires and an interview at a laboratory appointment. Data from the second assessment (Time 2) were not used in the present analyses because some parental involvement measures were not included at that assessment. At Time 3 (approximately one year after the first assessment; *M* time since Time 1 = 12.61 months), 196 adolescents participated in the study; at Time 4 (approximately six months after Time 3; *M* time since Time 3 = 5.69 months), 183 adolescents participated; at Time 5 (approximately six months after Time 4; *M* time since Time 4 = 5.13 months), 186 adolescents participated in the study; at Time 6 (approximately six months after Time 5; *M* time since Time 5 = 6.14 months), 198 adolescents participated in the study. There were no significant differences in age, gender, adherence, or indicators of parental involvement at the first time point between families who did and did not participate at each time point. Common reasons for withdrawing from the study included changes in family circumstances (19%), including the adolescent no longer living with the mother or deaths in the family, families too busy to participate (12%), and study demands (12%). Some families skipped time points (e.g., did not participate at Time 3 but returned to participate at Time 4). Reasons for “skipping” were not collected.

Measures

Adherence—Adherence to various aspects of the diabetes regimen over the preceding month was assessed with a 16-item adapted version of the Self-Care Inventory (La Greca, Follansbee, & Skyler, 1990). The adaptations, which were made after consultation with a certified diabetes educator and a person with diabetes, involved adding two items (i.e., “How well have you followed recommendations for counting carbohydrates?” and “How well have you followed recommendations for calculating insulin doses based on carbohydrates in meals and snacks?”) and updating the wording of existing items to capture current treatment standards (e.g., “How well have you followed recommendations for checking blood glucose with monitor?”). Adolescents, mothers, and fathers responded to items concerning adolescents’ adherence behavior on a scale from 1 (*never did it*) to 5 (*always did it as recommended without fail*). Average scores across items were analyzed. For this sample, at all time points $\alpha = .86$ for adolescent reports, $\alpha = .85$ for mother reports, and $\alpha = .83$ for father reports. Ratings of adherence were correlated across reporters at each time point ($ps < .01$), with correlations between teens and mothers ranging from $r = .36$ to .53, between teens and fathers from $r = .23$ to .39, and between mothers and fathers from $r = .38$ to .59.

Quality of relationship—The acceptance subscale of the Mother-Father-Peer (MFP) scale (Epstein, 1983) was used to assess the quality of the parent–adolescent relationship (i.e., the degree to which parent communicated love, acceptance, and appreciation of the child). Adolescents separately reported on relationship quality with their mothers (5 items) and fathers (5 items), rating each item from 1 (*strongly disagree with statement*) to 5 (*strongly agree with statement*; e.g., “My mother gives me the feeling that she likes me as I

am”). Mothers and fathers reported on their own acceptance of the adolescent. For this sample, at all time points, $\alpha = .83$ for adolescent reports, $\alpha = .73$ for mother reports, and $\alpha = .69$ for father reports. Correlations between teen and mother reports of maternal acceptance were significant ($ps < .05$) at three time points ($r = .20$ to $.30$), and correlations between teen and father reports of paternal acceptance were significant at three time points ($r = .21$ to $.27$).

Parental diabetes monitoring—Adolescents, mothers, and fathers completed a diabetes parental monitoring scale developed for this study. This scale was based on a general parental monitoring scale (Barber, 1996), and consisted of six items that captured adolescents’ views of their parents’ awareness of their daily activities concerning diabetes management. Adolescents reported how much mothers and how much fathers “really” know about aspects of their diabetes management (e.g., blood glucose readings; how much insulin they’ve taken) using a scale of 1 (*doesn’t know*) to 5 (*knows everything*). Mothers and fathers reported on their own knowledge. For this sample, at all time points $\alpha = .91$ for adolescent reports, $\alpha = .86$ for mother reports, and $\alpha = .87$ for father reports. Ratings of parental diabetes monitoring were correlated across reporters at each time point ($ps < .01$), with correlations between teens and mothers ranging from $r = .29$ to $.49$, and between teens and fathers from $r = .42$ to $.51$.

Parental behavioral involvement—To measure parental behavioral involvement, adolescents reported how often their mother and father (separately) helped with their diabetes in an average week using a scale from 1 (*0 days [never]*) to 5 (*daily*).

Self-efficacy—Adolescents and their mothers and fathers completed the Self-Efficacy for Diabetes Management Scale (Iannotti et al., 2006), reporting their confidence in the adolescent’s diabetes management across 10 problematic situations (e.g., “How sure are you that [you/your teen] can manage insulin intake when [you have/he or she has] eaten more or less than usual?”). Items were rated from 1 (*not at all sure*) to 10 (*completely sure*) and averaged. For this sample, at all time points $\alpha = .82$ for adolescent reports, $\alpha = .91$ for mother reports, and $\alpha = .93$ for father reports. Ratings of adolescents’ self-efficacy were correlated across reporters at each time point ($ps < .05$), with correlations between teens and mothers ranging from $r = .18$ to $.37$, teens and fathers from $r = .17$ to $.37$, and mothers and fathers from $r = .45$ to $.60$.

Statistical Analyses

A series of multilevel models were estimated in SAS PROC MIXED to test study hypotheses. Analyses began with an examination of the pattern and rate of change in each of the key study variables (i.e., adherence and indicators of parental involvement). Next, a series of lagged models were estimated, which predicted current adherence from indicators of parental involvement, while controlling for adherence at the previous assessment (i.e., predicting residualized change in adherence). Models predicting indicators of parental involvement and models predicting adherence were estimated separately for each reporter (adolescent, mother, and father), using age as the marker of time, centered at age 13 (near the mean age of the sample across all time points). Separate models were estimated for each

reporter because some teen-report variables were not assessed in parents. For all models, both fixed effects and variance components were examined. Fixed effects are effects that have been averaged across everyone in the analysis (e.g., average intercept, average slope). Variance components indicate how much individuals' trajectories vary from the average trajectory (e.g., does everyone in the sample have the same slope, or is there variation in individuals' slopes?). In all models, a quadratic effect for the slope (i.e., age²) was tested and subsequently removed because its fixed effects and variance components were not significant. Interactions between age and indicators of parental involvement were also nonsignificant and were therefore removed from the models.

In models predicting adherence, indicators of parental involvement were entered simultaneously, and analyses controlled for the effects of gender, time since diagnosis, ethnicity, socioeconomic status (SES; Hollingshead Index), single-parent household, and insulin pump status (entered as a within-subjects variable, as pump status varied across time). For each adherence model, the percentage of variance in adherence explained by the set of predictors was calculated, where R^2 represents the squared correlation between observed adherence and values of adherence predicted by the model (Singer & Willett, 2003).

For each of the adherence models, both within-person and between-person indicators of parental involvement were examined as predictors of residualized change in adherence. Within-person indicators of parental involvement (i.e., indicators of parental involvement that could vary at each time point) were centered at participants' baseline (Time 1) value using a group- or person-centering technique so that these variables represented deviation, or cumulative change, from the first time point (Hoffman & Stawski, 2009). Between-person indicators of parental involvement were also included in the models, representing the baseline (Time 1) values. Including both between- and within-person indicators in the model allowed for an examination of the unique effects of Time 1 parental involvement and cumulative change in parental involvement over time.

It was hypothesized that cumulative change in adolescents' diabetes self-efficacy would mediate the effects of cumulative change in parental involvement on subsequent adherence. The same centering technique used with the parental involvement variables was used with self-efficacy (i.e., individuals' self-efficacy at each time point minus their self-efficacy at Time 1) to create a variable representing cumulative change in self-efficacy. Mediation was examined using the Bauer test to determine the significance of the indirect effect, a test which is similar to the Sobel test but is appropriate for use in multilevel models (Bauer, Preacher, & Gil, 2006). The Bauer test adds an adjustment to the Sobel test to account for the covariance between the two pathways in a mediation model (i.e., paths between the predictor and mediator, and the mediator and outcome) that may exist in time-varying covariate models. All analyses were conducted on a planned, a priori basis to address specific aims of the grant that supported this study.

Results

Trajectories of Adherence

Unconditional multilevel models examined trajectories of change in adherence behavior with age. Results indicated a linear trajectory with significant variance in intercepts, and average intercepts of 3.91 ($SD = .37$), 3.55 ($SD = .42$), and 3.60 ($SD = .45$) for adolescent, mother, and father reports, respectively. Intercept values indicated that adolescents believed they “usually” followed recommendations for management (e.g., for checking their blood glucose), whereas their parents reported they adhered between 50% of the time and “usually.” For all reporters, there were small but statistically significant average declines in adolescents’ adherence, with fixed effects coefficients of $-.08$ ($SD = .09$), $-.07$ ($SD = .06$), and $-.05$ ($SD = .05$) for adolescent, mother, and father reports, respectively. There was also a significant variance component for the slope, indicating that adolescents differed in their rate of decline across age.

Trajectories of Parental Involvement

A series of multilevel models were estimated to identify trajectories of parental involvement across adolescence (ages 10–17). First, three unconditional models were examined for trajectories of adolescent-reported maternal involvement (i.e., changes in [a] acceptance, [b] monitoring, and [c] behavioral involvement); there were also three models for adolescent-reported paternal involvement. Two models were examined for mother-reported maternal involvement and two for father-reported paternal involvement (parents’ reports of their own behavioral involvement were not obtained and could not be modeled).

Significant average (linear) declines with age occurred in all markers of parental involvement ($ps < .05$) except adolescent and maternal reports of maternal relationship quality, in which declines approached significance ($p = .09$ and $p = .11$, respectively; see Figure 1). All markers of parental involvement had significant variance in intercepts ($ps < .05$), indicating significant differences between families in parental involvement when adolescents were 13 years old. Many indicators of parental involvement also had significant variance in slopes, indicating significant differences in rates of change in involvement with age (with the exception of teen-reported maternal behavioral involvement, father reports of his own diabetes monitoring, and mother and father reports of their own acceptance). On average, when adolescents were 13 (approximate average age of the sample across all time points), participants reported mothers helping with diabetes 5 to 7 days per week, and fathers helping with diabetes 3 to 4 days per week. Mothers reportedly knew “a lot” and dads knew “something” about adolescents’ diabetes management. Finally, participants felt between “somewhat” to “strongly” that mothers and fathers provided warmth and acceptance.

Predicting Adherence From Parental Involvement

Lagged multilevel models were estimated to predict adolescents’ adherence from age and indicators of parental involvement, while controlling for adherence at the previous time point (i.e., predicting residualized change in adherence). Results of these analyses are provided in Table 1. After controlling for demographic and disease-related variables, as well

as adherence at the previous assessment, several of the adolescent-reported indicators of maternal involvement were significantly associated with change in adherence. Higher baseline (Time 1) levels of maternal relationship quality and diabetes monitoring predicted less decline in adherence over time. In addition, smaller cumulative declines in maternal acceptance and diabetes monitoring (i.e., within-person, or time-varying, acceptance and monitoring, centered at people's baseline value) were associated with lower subsequent decline in adherence. In the mother-report model, similar to results for the adolescent-report model, greater maternal diabetes monitoring at baseline and less change in maternal monitoring (from baseline) predicted slower declines in adherence over time. In the model predicting lagged adherence from adolescent-reported paternal involvement, higher baseline paternal acceptance and diabetes monitoring were associated with slower declines in adherence over time. In addition, slower declines in paternal acceptance and monitoring were associated with slower declines in adherence. Results for the model of father's report of his own involvement were similar to those for adolescent-reported paternal involvement.¹

The Mediating Role of Self-Efficacy

In order to determine whether longitudinal changes in self-efficacy mediated longitudinal associations between parental involvement and adherence, multilevel analyses examined the simultaneous effects of cumulative change in parental involvement and cumulative change in adolescents' diabetes self-efficacy. In each model, cumulative change in self-efficacy predicted subsequent change in adherence for all reporters (for adolescent-report, $b = .102$, $SE = .011$; mother-report, $b = .046$, $SE = .010$; father-report, $b = .049$, $SE = .013$). In addition, there were reductions in each of the within-person indicators of parental involvement, suggesting the potential for mediation by within-person changes in self-efficacy. After estimating the multilevel models, a Bauer test was performed to determine whether there were any significant indirect, or mediated, effects of change in parental involvement on change in adolescents' adherence, through change in adolescents' diabetes self-efficacy. Bauer tests indicated significant mediation (by self-efficacy) for each of the following indicators of parental involvement: adolescent reports of mothers' acceptance (95% CI [.0011, .0718]), adolescents' reports of mothers' diabetes monitoring (95% CI [.0067, .0616]), and mothers' reports of her acceptance (95% CI [.0156, .1347]).

Discussion

The present study is the first to demonstrate that multiple facets of parental involvement in diabetes management decline linearly across the adolescent years, and that longitudinal declines in both mothers' and fathers' involvement predict deterioration in adherence across

¹In the adherence models, one goal was to examine the unique contributions of monitoring, relationship quality, and behavioral involvement. Although adolescents reported mothers' and fathers' behavioral involvement, mothers and fathers were not asked to report their *own* behavioral involvement. They did, however, report "parental" behavioral involvement (i.e., indicating how much they or the child's other parent were responsible for a particular diabetes management task), with a 28-item modified version of the Diabetes Responsibility Scale (Rubin, Young-Hyman, & Peyrot, 1989). In the mother- and father-report models, we began by including this parental behavioral involvement variable so we could see the unique effects of maternal/paternal monitoring and relationship quality on adherence after controlling for behavioral involvement. Once it was determined that maternal/paternal monitoring and relationship quality retained their relationships (i.e., direction of association and significance) with adherence, with or without parental behavioral involvement in the model, parental behavioral involvement was removed so the mother-report and father-report models, like the adolescent-report models, included only indicators of mothers' own involvement or fathers' own involvement.

adolescence. These findings also provide some insight into the process by which parental involvement contributes to adherence. Specifically, declines in maternal diabetes monitoring and relationship quality predicted less increase in diabetes self-efficacy, which, in turn, predicted declines in adherence across adolescence. The results are important, as declining adherence places adolescents at increased risk for a variety of health problems. These results confirm previous cross-sectional findings (Anderson et al., 1997; Berg et al., 2011) and provide evidence for longitudinal associations linking parental involvement and adherence across adolescence.

Across adolescence, components of parental involvement for both mother and father declined, with the exception of maternal acceptance, which did not exhibit average change but did demonstrate variability in participants' levels of change. The broader adolescent literature indicates that parental monitoring and behavioral involvement decline during adolescence in a variety of domains (e.g., keeping track of adolescents' activities throughout the day, providing assistance with homework; Laird, Criss, Pettit, Bates, & Dodge, 2009). These declines have often been attributed to adolescents spending less time with parents and more time engaged in activities outside of the home (Larson et al., 1996), as well as to adolescents' increasing desire for autonomy. In light of the present data, it is likely that these normative developmental changes also contribute to decreasing parental involvement in the context of Type 1 diabetes. In addition, decreasing parental involvement in diabetes management may result from parents' desire for adolescents to learn how to manage their own diabetes, their belief in adolescents' competence to manage diabetes on their own, or simply feeling burned out or too busy to help adolescents manage their diabetes (Palmer et al., 2004).

Declines in both maternal and paternal involvement were associated with declines in adolescent adherence over time. Results suggest that declines in adherence during adolescence may be attributed, at least in part, to declines in mothers' and fathers' diabetes monitoring and relationship quality with their adolescent. These associations were significant after controlling for parents' declining behavioral involvement and parental involvement when participants entered the study. In contrast, declines in mothers' and fathers' behavioral involvement did not uniquely predict declines in adherence (after accounting for other indicators of parental involvement). The lack of results for behavioral involvement may be due to the measure utilized in this study, a single item for mothers and fathers rather than a more traditional measure of who is responsible for diabetes management tasks (Anderson et al., 1990; Helgeson et al., 2008). Additional research using these more standard measures of behavioral involvement will be needed to ascertain the relation between changes in behavioral involvement and adherence.

The consistency of most of the results across reporters lends strong support for the findings. Further, relationships between parental involvement and adherence were consistent across the age range in the sample (i.e., no interactions between parental involvement and age), indicating that sharper declines in relationship quality and diabetes monitoring were just as detrimental for adherence among older adolescents as they were for younger adolescents. Thus, despite the fact that declines in parental involvement may be normative, maintained

parental involvement across adolescence may sustain adherence during this developmental period.

Declines in parental involvement may contribute to declines in adherence because they impede the development of adolescents' diabetes self-efficacy. This study examined cumulative changes in both parental involvement and diabetes self-efficacy (i.e., changes at each time point relative to baseline values). On average, adolescents experienced increases in diabetes self-efficacy as they got older. Adolescents with greater decline in maternal relationship quality and (for adolescent reports) maternal diabetes monitoring, however, were less likely to experience growth in diabetes self-efficacy compared with those who had more positive maternal involvement trajectories. Further, less cumulative growth in diabetes self-efficacy at a particular time point was associated with poorer subsequent adherence. Analyses confirmed that longitudinal associations between maternal involvement and adherence were mediated by changes in adolescents' diabetes self-efficacy.

Higher maternal involvement may provide an excellent training ground for the development of self-efficacy (Paley, Conger, & Gordon, 2000), in this study operationalized as confidence in managing problematic diabetes situations, such as modifying insulin dosage in response to changes in diet. Mothers are more involved in their adolescents' daily diabetes management (Palmer et al., 2011), and the nature of this involvement may be associated with self-efficacy. Parents who are involved through a high-quality relationship work collaboratively with children surrounding diabetes problems (Berg, Schindler, & Maharajh, 2008) and may foster the development of self-efficacy as the child works through stressful situations together with the parent (Wiebe et al., 2005). When collaboration occurs together with parental monitoring, parents' knowledge about adolescents' diabetes management can guide appropriate scaffolding as adolescents and parents work together, such that the adolescent gains the self-efficacy to work through problems associated with adherence behaviors more effectively in the future. In addition, parents who keep track of adolescents' diabetes behaviors may be better able to provide support or assistance at key times, so adolescents experience less diabetes problems and greater self-efficacy over time (Berg et al., 2011). Future research involving observational measures of parents and children (Jaser & Grey, 2010) working together on issues of nonadherence may be helpful in understanding the links between parental involvement, self-efficacy, and adherence behavior.

Results of this study suggest that slowing the decline in parental involvement that typically occurs across adolescence may improve adolescent adherence behavior. Interventions that target parents' behavioral assistance with diabetes management (e.g., Ellis et al., 2007; Wysocki et al., 2008) have achieved some success at improving diabetes outcomes. The present findings that parental monitoring and relationship quality have unique effects on adherence suggest that such interventions may be enhanced by adding components that specifically target these facets of parental involvement (see Dishion & Stormshak, 2007). The finding that associations between parental involvement and adherence were consistent across age suggests that interventions are not bound to a particular high risk period and that efforts to promote involvement may be helpful even during later adolescence. Finally, the finding that self-efficacy beliefs partially mediated the association between declining

parental involvement and poorer adherence points to alternative or additional avenues for maintaining adherence across adolescence.

Although this study had many strengths, there are some limitations to consider when interpreting the findings. The sample was predominantly Caucasian, which could limit the generalizability of the results. Future research should consider whether there are ethnic differences in longitudinal relationships between parental involvement, diabetes self-efficacy, and adolescents' diabetes outcomes. A few self-report measures used in this study were adapted slightly from their original forms. Although multiple reporters were used, and results of analyses were similar across reporters, future research may be strengthened by the use of more objective measures, particularly for adolescents' adherence behavior. "Parental involvement" was conceptualized as having three distinct components (behavioral involvement, relationship quality, and monitoring), but there may be other facets of parental involvement not examined in this study, such as parental guidance or soft control (e.g., reminders and advice), positive reinforcement, or parenting style, as well as "negative" aspects of parental involvement, such as parental psychological control (Butler, Skinner, Gelfand, Berg, & Wiebe, 2007) and parent-adolescent conflict (Ingerski, Anderson, Dolan, & Hood, 2010). Finally, metabolic control (HbA1c) was not included in these analyses because of problems with model convergence, likely due to stability in participants' metabolic control over time (e.g., Luyckx & Seiffge-Krenke, 2009). Future research should consider whether declines in parental involvement contribute to deterioration in metabolic control across adolescence.

This study provides an important contribution to the literature on parental involvement in the context of diabetes management during adolescence. By measuring multiple aspects of parental involvement and adherence at multiple time points, we were able to demonstrate longitudinal links between declining parental involvement and declining adherence across time and the potential mediating process of changing adolescent self-efficacy. Future work is needed to explore the process by which maternal involvement may bolster adolescent self-efficacy for diabetes management as well as when parents may safely reduce their involvement in their adolescents' or emerging adults' diabetes management.

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Figure 1. Trajectories of teen reported parental involvement. (a) Behavioral involvement (note parent reports were not measured); (b) Diabetes monitoring; (c) Parental acceptance.

Table 1
Results of Multilevel Models Examining Associations Between Parental Involvement and Change in Adolescents' Adherence

	Teen report (Model 1): Maternal involvement coefficient and SE	Teen report (Model 2): Paternal involvement coefficient and SE	Mother report model: Maternal involvement coefficient and SE	Father report model: Paternal involvement coefficient and SE
Fixed effects				
Intercept	2.86 0.24***	3.02 0.26***	2.28 0.21***	2.75 0.28***
Gender (1 = Male)	0.01 0.05	0.03 0.06	0.03 0.04	0.02 0.06
Time since diagnosis (centered at 1 yr)	0.00 0.01	-0.01 0.01	-0.01 0.01	-0.02 0.01
Pump status (1 = Yes)	-0.10 0.05**	-0.10 0.05*	-0.07 0.04	-0.15 0.06***
Ethnicity (1 = Caucasian)	-0.01 0.11	0.04 0.13	0.06 0.10	-0.10 0.14
Hollingshead index (mean-centered)	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
Single-parent household (1 = yes)	0.09 0.07	0.23 0.10**	0.03 0.07	-0.10 0.44
Age (centered at 13 years)	-0.03 0.02**	-0.05 0.02***	0.01 0.01	0.02 0.02
Adherence at Time 1	0.32 0.04***	0.25 0.04***	0.37 0.04***	0.33 0.05***
Indicators of parental involvement				
At Time 1 ^a				
Behavioral involvement	-0.07 0.03**	-0.02 0.03	-----NOT MEASURED-----	
Diabetes monitoring	0.12 0.04***	0.12 0.04***	0.20 0.04***	0.09 0.05**
Relationship quality	0.11 0.04**	0.15 0.04***	0.19 0.06***	0.17 0.07**
Deviation (change) from Time 1				
Behavioral involvement	-0.01 0.02	-0.02 0.02	-----NOT MEASURED-----	
Diabetes monitoring	0.15 0.03***	0.10 0.03***	0.25 0.04***	0.15 0.04***
Relationship quality	0.17 0.03***	0.13 0.03***	0.04 0.05	0.06 0.03**
Variance components				
σ_0^2 (intercept)	0.88 0.34***	0.89 0.41***	0.89 0.33***	1.15 0.37***
σ_{01}	-0.24 0.09***	-0.21 0.11**	-0.25 0.09***	-0.35 0.11***
σ_1^2 (adherence at Time 1)	0.07 0.02***	0.06 0.03**	0.07 0.03***	0.11 0.03***

	Teen report (Model 1): Maternal involvement coefficient and SE		Teen report (Model 2): Paternal involvement coefficient and SE		Mother report model: Maternal involvement coefficient and SE		Father report model: Paternal involvement coefficient and SE	
<i>R</i>	0.18	0.01***	0.14	0.01***	0.12	0.01***	0.12	0.02***
<i>R</i> ² $\hat{y}$	0.35		0.36		0.26		0.28	

Note. Models predicting residualized change in adherence (i.e., predicting current adherence while controlling for adherence at the previous time point).

^aTime 1 parental involvement variables were grand-mean centered (i.e., centered at the sample mean).

*
p < .06.
**
p < .05.

p < .01.