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Adolescent Disclosure to Parents and Daily Management of Type 1 Diabetes

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Abstract

Objective To examine how adolescents' daily disclosure to parents about type 1 diabetes management may foster a process whereby parents gain knowledge and are viewed as helpful in ways that may aid diabetes management. **Methods** A total of 236 late adolescents (*M* age = 17.76) completed a 14-day diary where they reported daily disclosure to, and solicitation from, their parents, how knowledgeable and helpful parents were, and their self-regulation failures and adherence; blood glucose was gathered from meters. **Results** Multilevel models revealed that adolescent disclosure occurred in the context of greater parent solicitation and face-to-face contact and was positively associated with adolescents' perceptions of parental knowledge and helpfulness. Disclosure to mothers (but not to fathers) was associated with better diabetes management (fewer self-regulation failures, better adherence). **Conclusions** Adolescent disclosure may be an important way that parents remain knowledgeable about diabetes management and provide assistance that serves to support diabetes management.

Key words: adolescents; diabetes; family functioning.

Type 1 diabetes management is a difficult self-regulation process for adolescents that occurs within the family environment. Diabetes management requires not only regulating the self, but also one's interpersonal context (Lansing & Berg, 2014). Adolescents must maintain normal ranges of blood glucose (BG) through testing multiple times per day and adjusting insulin, diet, and exercise along with parents who often assist in their management (Berg et al., 2013; Helgeson et al., 2014). An extensive literature demonstrates that diabetes management is enhanced when parents are more involved in adherence behaviors (Wiebe, Chow, Palmer, Butner, & Osborn, 2014), are knowledgeable about diabetes management (Ellis et al., 2007), and collaborate with their adolescent (Nansel et al., 2009). We are just beginning to understand, however, the ways in which adolescents may actively manage the flow of information about diabetes to parents (Tilton-Weaver 2014) through disclosure (Osborn et al., 2013).

Diabetes-related disclosure refers to adolescents spontaneously telling parents about diabetes problems without parental solicitation (Osborn et al., 2013; Stattin & Kerr, 2000). Such spontaneous disclosure may provide parents information, allowing them to be knowledgeable and involved with diabetes in helpful ways. Disclosure may be an important way that adolescents regulate their

interpersonal context as they manage diabetes more independently from parents during late adolescence and emerging adulthood. The present study examined the family context of daily disclosure during late adolescence to understand (1) factors that may foster disclosure (e.g., parental acceptance, solicitation of information, daily contact with parents), (2) whether disclosure and parental solicitation are a means by which parents gain knowledge of their adolescents' diabetes and provide help, as well as (3) whether such disclosure and parental solicitation are associated with better diabetes management (i.e., fewer self-regulation failures, better adherence, and glycemic control).

Adolescent disclosure to parents typically occurs in the context of high-quality, warm, and accepting parent–child relationships (Hare, Marston, & Allen, 2010; Solis, Smetana, & Comer, 2015; Tilton-Weaver, 2014) and is associated with better health, lower delinquency, and fewer depressive symptoms (Kerr, Stattin, & Burk, 2010). For adolescents with type 1 diabetes, disclosure to parents has been associated with better adherence to the diabetes regimen (Osborn et al., 2013). Although disclosure to parents declines in frequency across early adolescence (Keijsers & Poulin, 2013), it may be especially important during late adolescence (Main et al., 2015), as this may be the primary vehicle through which parents gain knowledge about their adolescents' diabetes, given their less proximate daily contact with adolescents.

Disclosure to parents about diabetes management has only been examined at the between-person level (Osborn et al., 2013); however, disclosure and parents' solicitation of diabetes information likely fluctuate on a daily basis within persons (Solis et al., 2015). Specifically, daily fluctuations in disclosure may occur as adolescents vary in their daily contact with parents and as parents solicit information from adolescents. Adolescent disclosure may occur more often on days when youth have face-to-face contact with parents, given evidence that time spent together in family activities predicts higher adolescent disclosure (Willoughby & Hamza, 2011). Consistent with the idea that disclosure varies daily, Solis et al. (2015) found that adolescent disclosure was more frequent on days when parents solicited information from adolescents regarding their personal activities.

Daily adolescent disclosure and parental solicitation may provide parents with the knowledge they need to help adolescents avoid self-regulation failures and persist in adherence tasks that maintain glycemic control (Osborn et al., 2013). Parental knowledge is thought to arise from both adolescents' active disclosure and parents' solicitation of information from adolescents (Racz & McMahon, 2011). The dual processes of adolescent disclosure and parental solicitation of information may assist adolescents with the daily regulation of diabetes that is so essential to adherence (Berg et al., 2014). For instance, adolescent disclosure of information about diabetes management to parents (e.g., "I went high.") and parental solicitation of that information may allow parents to assist adolescents' self-regulation (e.g., remind the adolescent to test). Reducing self-regulation failures such as forgetting to test is associated with better adherence (Berg et al., 2014). Reciprocal relations between disclosure and solicitation have been found, with some evidence that disclosure is the key process in understanding positive youth outcomes (Keijsers, Branje, VanderValk, & Meeus, 2010). Diabetes management is an excellent context in which to examine these processes, as adolescents regularly experience self-regulation failures (Berg et al., 2014) and their disclosure may allow parents to assist in ways that bolster adherence behaviors.

Adolescents may disclose information about their diabetes management differentially to mothers versus fathers and benefit more in their management efforts from disclosure to mothers. Mothers are typically more involved in daily parenting matters than are fathers (Racz & McMahon, 2011). Further, mothers are more knowledgeable about adolescents' daily activities through both mothers' greater solicitation of information and being the target of adolescent disclosures (Waizenhofer, Buchanan, & Jackson-Newsom, 2004). Mothers' greater involvement than fathers in adolescents' daily lives generally holds true in diabetes management as well (Seiffge-Krenke, 2002), and there is recent evidence that adolescents disclose more to mothers than to fathers about diabetes (Main et al., 2015). Adolescent daily disclosures to mothers may thus be more beneficial than disclosures to fathers because of higher maternal involvement in the daily details of disease management.

The primary aim of the study was to examine the broader family context of disclosure (i.e., across families or between-persons) and the daily process of disclosure to parents (i.e., within-persons) surrounding diabetes care among late adolescents with type 1 diabetes. We first examined between-person differences in the family context of diabetes disclosure by exploring associations of daily disclosure to survey measures of the overall quality of the parent–child relationship and adolescents' perceptions of parents' knowledge. We hypothesized that greater disclosure to mothers and fathers would occur in the context of high-quality parent–child relationships, where parents were knowledgeable about their adolescent's diabetes behavior. Second, we examined the daily process of disclosure (within-person differences) predicting that greater daily disclosure would occur on days with face-to-face parental contact and greater parental solicitation, and would be associated with greater adolescents' perceptions of parental helpfulness as well as with fewer self-regulatory failures, better adherence,

and lower BG. We examined adolescents' disclosure to mothers and fathers, hypothesizing that adolescent disclosure to mothers may be more beneficial for diabetes management given their greater daily involvement in diabetes management.

Methods

Participants

High school seniors with type 1 diabetes were recruited for a 2-year longitudinal study on diabetes and self-regulation during late adolescence and emerging adulthood. Participants were recruited from three outpatient pediatric endocrinology clinics in two southwestern U.S. cities by a research assistant in clinic, or by mail and phone. Of the qualifying 507 individuals approached, 301 (59%) initially agreed to participate. Of those who agreed, 247 adolescents (82%) completed baseline assessments. Reasons for not participating included being too busy in their senior year to participate (34%), lack of interest (33%), and 20% declined to give a reason. At one site, the institutional review board permitted data to be collected comparing those who did not participate to those who did. At this site, participants did not differ from those who declined on HbA1c, time since diagnosis, gender, or pump status (*p*s > .05). However, those who participated were slightly younger, *M* (*SD*) = 17.77 (0.43) versus 17.91 (0.48) years, $t(203) = 2.274$, $p = .024$, and more likely to be Latino (21% vs. 11%), χ^2 ($df = 1$) = 3.88, $p = .049$, compared with those who declined.

Adolescents were eligible to participate if they had been diagnosed with type 1 diabetes for at least 1 year (*M* length of diagnosis= 7.35 years, *SD* = 3.88), had English as their primary language, were in their final year of high school, lived with a parent (68.4% lived at home with both biological parents, 27.1% with one biological parent, and 4.5% lived with adoptive parents or grandparents), would be able to have regular contact with parents over the subsequent 2 years (consistent with objectives of the broader longitudinal study), and had no condition that would prohibit study completion (e.g., severe intellectual disability, blindness).

Consistent with the patient population at participating clinics, 75.2% of the full sample ($N = 247$) identified as non-Hispanic White, 14.2% Hispanic, 4.8% African American, and the remainder Asian/Pacific Islander, American Indian, or more than one race. Patients were 17.76 years old on average (*SD* = 0.39) and 60% were female. Parents had a range of educational backgrounds, with 12.9% of mothers and 18.2% of fathers having a high school education or less, 37.2% of mothers and 25.1% of fathers with some college or a vocational degree, and 34% of mothers and 46.3% of fathers with a bachelor's degree or higher.

The present study analyzed baseline data from participants ($N = 236$) who responded to the daily diary. Adolescents in this subsample were 17.77 years of age (*SD* = 0.39) on average and had been diagnosed with type 1 diabetes for an average of 7.34 (*SD* = 3.88) years. In this subsample, 62% of adolescents were female and 43% of patients reported using an insulin pump. Sixty-three percent of our analyzed sample was above the American Diabetes Association's (ADA) age-specific recommendations (HbA1c < 7.5%) for glycemic control (*M* HbA1c = 8.27, *SD* = 1.62).

Procedure

The study was approved by the appropriate institutional review boards, with parents providing informed consent and adolescents providing consent or assent. Adolescents completed an online survey assessing the family context, subsequent to a laboratory session and then an online diary for 14 days. For measures of mother and father involvement, adolescents selected one mother and father figure to report on consistently across time. If adolescents had more than one mother or father figure, they selected the mother or father figure who was most involved in their diabetes care (97.2% of adolescents nominated biological mother and 90.9% nominated biological father). To facilitate diary completion, adolescents received phone calls or text messages daily if they had not completed the diary by 9 pm. Adolescents were paid $50 for lab procedures and the online survey, and $5 for each daily diary completed.

Measures

Survey Measures

Family Context

To assess between-person *disclosure to parents*, adolescents completed a modified scale from Stattin and Kerr (2000) to capture how much information adolescents voluntarily disclosed about their diabetes. Adolescents rated 3 items (e.g., "I spontaneously tell my mother/father about what is going on with my diabetes management") on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale. The measure has good reliability (Stattin & Kerr, 2000), with the diabetes-specific scale showing good reliability in the present sample ($\alpha = .83$ and .88 for disclosure to mothers and fathers, respectively). To assess *parental acceptance*, the five-item acceptance subscale from the Mother–Father–Peer scale (Epstein, 1983) was used. Adolescents rated perceptions of mothers and fathers separately, using a 1 (*strongly disagree*) to 5 (*strongly agree*) scale. Reliability in the present sample was $\alpha = .86$ and .88 for mother and father, respectively. To assess *parental knowledge*, adolescents completed seven-items (Berg et al., 2008) reporting separately how much mothers and fathers "really" know about their diabetes care (e.g., blood sugar

readings) using a 1 (*doesn't know*) to 5 (*knows everything*) scale. Reliability in the present sample was $\alpha = .92$ and $\alpha = .96$ for mother and father, respectively.

Adherence

Adolescents completed an adapted seven-item version of the Self-Care Inventory (La Greca, Follansbee, & Skyler, 1990; Lewin et al., 2009) rating how often behaviors were completed as recommended in the past month (1 = *did not do* to 5 = *always did without fail*). In the present study, the scale had good reliability ($\alpha = .82$), with an average score used.

Metabolic Control

Glycosylated hemoglobin (HbA1c) was obtained from blood samples collected during the laboratory session and processed by mail-in assay kits from CoreMedica Laboratories. HbA1c reflects average BG over the prior 2–3 months; higher levels indicate poorer metabolic control.

Daily Diary Measures

All daily diary measures were created for the present study by the authors.

Daily Processes of Disclosure

To assess *daily adolescent disclosure* about diabetes to each parent, adolescents responded yes or no to the prompt "Did you tell your mother/father about things that happened with your diabetes today, without her/him asking you?" To assess *parental solicitation*, adolescents responded yes or no to "Did your mother/father ask what happened with your diabetes today?" To assess the methods by which adolescents had contact with parents, adolescents were asked, "How many times did you and your mother/father talk *face-to-face* (in person)?", with response options ranging from 0 up to 11 ($\geq$11 times). In addition, adolescents were asked how many times they were in contact with mother/father each day via email, phone, texting, or social networking using the same scale. A sum of *nonface-to-face* contact was calculated across these forms of contact for each parent.

To measure *parental knowledge* adolescents rated "How much does mother/father REALLY know about the diabetes problems you had today (e.g., high or low blood glucose)" on a 1 = *nothing* to 5 = *a lot* scale. To measure *parental helpfulness*, adolescents rated how helpful their mother/father was in providing support for diabetes on a 1 (*not at all helpful*) to 5 (*very helpful*) scale.

Daily Self-Regulation Failures

Adolescents reported daily on their experience of eight failures in diabetes self-regulation (e.g., "I kept putting off my BG testing." "Each time I was about to test my BG, I got distracted by something else.") surrounding monitoring BG, a crucial and difficult daily adherence behavior (Berg et al., 2014; Hood et al., 2009) using a 1 (*strongly disagree*) to 5 (*strongly agree*) scale. An average, daily score was used, with higher values indicating more failures. Interitem reliability of the eight items was calculated via random intercept models, with both time and item treated as nested levels and was excellent ($\alpha = .98$).

Daily Adherence

Adolescents completed a brief index of adherence that included the seven items from the survey measure of the Self Care Inventory, as noted above. Ratings were averaged across all items such that higher scores indicated higher adherence ($\alpha = .82$).

BG Levels

At the end of each day, adolescents entered that day's BG value and time of each BG check into the online diary directly from their glucometers. A mean BG was created for each individual's BG levels across the day. We used self-reported BG for many reasons: participating clinics did not routinely download glucometer data, the larger longitudinal study precluded physical downloads as adolescents were geographically mobile, and other technologies such as Bluetooth did not exist at the outset of the larger study.

Data Analysis Plan

First, to understand how daily disclosure was associated with the family context, we examined correlations among disclosure averaged across 14 days and survey measures of the family (e.g., acceptance, knowledge, disclosure). Second, to examine daily within-person processes of disclosure, diary data were analyzed using multilevel models.

Before conducting the study, we performed a power analysis through a series of Monte Carlo Simulations in Mplus (Muthén & Muthén, 1998–2011), using our previous daily diary work with adolescents for effect sizes. With a sample size of 200 we had a high level of power to detect significant effects (power = .99).

Because adolescents reported on both mothers and fathers, we modeled the data through multilevel models with application to matched pairs to account for dependencies (Raudenbush, Brennan, & Barnett, 1995). These analyses simultaneously estimated a single model for adolescents' reports of mothers and fathers for each dependent variable. Multilevel models were tested to predict daily disclosure from daily face-to-face and nonface-to-face contact with parents and parental solicitation using the dichotomous variable of disclosure to mothers and fathers as simultaneous dependent measures (Bernoulli's distribution was specified). Next, we examined whether both disclosure and solicitation (as independent variables) were associated with adolescents' perceptions of mother

and father knowledge of diabetes and helpfulness (dependent measures). Third, we conducted multilevel models to examine daily associations of adolescent disclosure and parental solicitation to both mothers and fathers (as independent variables) predicting self-regulation failures, adherence, and BG as dependent measures in three models, one for each dependent measure.

For all models, we tested both within- (daily) and between-person (across the 14 days) effects by group centering level 1 predictors and including the between-person means across the 14 days as level 2 predictors, thereby separating out within- versus between-person effects (see Hoffman & Stawski, 2009). We provide the example below for the models examining the relationship between solicitation from and disclosure to mothers and fathers predicting mothers' and fathers' knowledge.

At Level 1 (capturing within person variation), we simultaneously examined same day associations of (1) solicitation from and disclosure to mothers predicting adolescents' perceptions of mothers' knowledge and (2) solicitation from and disclosure to fathers predicting adolescents' perceptions of fathers' knowledge. These models provide separate intercepts and coefficients for mother and father data. At Level 2 (capturing between person variation), we used mean levels of mothers' and fathers' solicitation and adolescents' disclosure to predict the intercept (mean levels of knowledge) at Level 1. In all analyses, we analyzed five multiply imputed data files using SPSS Multiple Imputation to account for missing data. Missing items on surveys were imputed as a function of the other scale items and missing daily diary values were imputed as a function of other daily items. We did not impute data for a single day if adolescents skipped that day of the diary. On average, adolescents completed 11.22 of 14 diary days. We examined the daily diary data for outliers using leverage for each predictor in the model and reran analyses excluding identified outliers. All analyses were the same excluding outliers, so we maintained these days in the analyses. In all analyses conducted, gender differences were examined, but no gender differences were found ($ps > .30$). Because time since diagnosis and mothers' education were not associated with outcomes, these covariates were not included in models (with exception of length of diagnosis and BG mean).

Results

Family Context of Disclosure

The means in Table I reveal that on the survey, adolescents reported mothers know slightly above "something about my diabetes" whereas fathers know slightly less. On a daily basis, adolescents reported they disclosed to mothers on 27% and to fathers on 19% of the days, and that mothers solicited

Table 1 Means and Correlations of Study Variables

	M (SD) teen report of fathers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	M (SD) teen report of mothers
1. S disclosure	2.97 (1.02)	.56**	.32**	.52**	.45**	.37**	.27**	.19**	.47**	.47**	.33**	–.31**	.22**	–.07	–.11	3.20 (0.97)
2. S acceptance	4.29 (.90)	.45**	.52**	.23**	.08	.15*	.24**	.17**	.17**	.25**	.15*	–.06	.20**	–.13*	–.08	4.33 (0.89)
3. S knowledge	2.72 (1.17)	.55**	.16*	.61**	.42**	.43**	.29**	.17*	.55**	.39**	.38**	.43**	.41**	–.10	–.23**	3.30 (1.05)
4. D disclosure	.19 (0.29)	.29**	.09	.41**	.59**	.72**	.28**	.19**	.63**	.58**	.25**	–.30**	.19**	.05	–.21**	.27 (0.32)
5. D solicitation	.24 (0.34)	.24**	.08	.40**	.72**	.52**	.33**	.22**	.70**	.63**	.21**	–.28**	.14*	.06	–.12	.33 (0.34)
6. D face contact	4.19 (2.73)	.16*	.21**	.36**	.38**	.31**	.70**	.13	.31**	.37**	.18**	–.07	.12	–.13	–.17**	5.39 (2.98)
7. D nonface	1.75 (2.17)	.17*	.12	.12	.34**	.30**	.14*	.62**	.24**	.27**	.06	.003	.08	.07	–.03	3.03 (2.57)
8. D knowledge	2.12 (1.15)	.30**	.18*	.50**	.66**	.65**	.35**	.31**	.68**	.84**	.25**	–.28**	.19**	.09	–.19**	2.56 (1.22)
9. D helpfulness	2.32 (1.2)	.40**	.28**	.51**	.60**	.60**	.48**	.34**	.82**	.67**	.31**	–.29**	.28**	.02	–.22**	2.77 (1.21)
10. S adherence	3.98 (.60)	.30**	.28**	.30**	.13	.12	.19**	.08	.19**	.23**	NA	–.57**	.66**	–.25**	–.50**	
11. D S-R failures	2.09 (.82)	–.25**	–.24**	–.30**	–.16*	–.17*	–.11	–.06	–.20**	–.20**	–.57**	NA	–.61**	.22**	.38**	
12. D adherence	4.14 (.69)	.25**	.27**	.27**	.10	.09	.16*	.09	.15*	.21**	.66**	–.61**	NA	–.29**	–.55**	
13. HbA1c	8.26 (1.63)	–.10	–.23**	–.12	.14*	.15*	–.12	.08	.14*	.04	–.25**	.22**	–.29**	NA	.45**	
14. D BG mean	188.82 (58.48)	–.15*	–.22**	–.13	–.10	–.02	–.12	–.02	–.07	–.12	–.50**	.38**	–.55**	.45**	NA	

Note. Correlations above the diagonal are for adolescents' reports of mothers, below the diagonal are for their reports of fathers. The diagonal presents correlations between adolescent report of mother and father, when available. BG = blood glucose, NA= not applicable. S = survey measure, D = diary measure.

$^{*}p < .05$; $^{**}p < .01$.

information on 33% and fathers on 24% of days. Adolescents reported frequent daily face-to-face contact with mothers and fathers with less nonface-to-face contact. Correlations revealed that greater acceptance and parental knowledge were associated with greater reports of disclosure from the surveys (see Table I). Further, greater disclosure to mothers and fathers aggregated over the 14 diary days was associated with greater reports of disclosure on the survey, lending validity to our daily measure of disclosure. Average disclosure over the 14 days was associated with greater amounts of parental knowledge, but not with greater acceptance. Consistent with the idea that disclosure may be part of a social-regulatory process that aids diabetes management, average disclosure to mothers across the 14 days was associated with fewer self-regulatory failures, higher daily adherence, and lower BG mean.

Daily Processes of Disclosure

Multilevel models were conducted to understand whether disclosure to parents (as a dichotomous dependent measure) was more likely on days when adolescents had more frequent face-to-face or nonface-to-face (e.g., texting, email) contact with parents. As can be seen in Table II, adolescent disclosure to mothers and fathers was more likely on days when adolescents reported more face-to-face contact with both mothers and fathers (i.e., the within-person effect). In addition, the between-person effects followed this pattern indicating that in general adolescents reported greater disclosure across the 14 days when they also reported greater face-to-face contact with both mothers and fathers. Similar analyses conducted for nonface-to-face contact indicated that neither adolescent disclosure to mothers nor to fathers was associated with daily nonface-to-face contact. However, overall greater (between-person) nonface-to-face contact with mothers and fathers was associated with greater disclosure across the 14 days.

We also examined whether disclosure was more frequent on days when adolescents reported that parents solicited information from them. Disclosure to mothers was more likely on days that adolescents reported mothers' solicitation; disclosure to fathers more likely on days that adolescents reported fathers' solicitation. In addition, across the 14 days, greater mean levels of disclosure occurred when fathers and mothers solicited information across the 14 days.

To examine whether disclosure and solicitation allowed parents to gain knowledge about diabetes management, we conducted analyses with adolescents' perceptions of mothers' and fathers' knowledge as dependent measures (see Table III). Both disclosure to and solicitation from mothers and fathers had significant within- and between-person effects. Specifically, on days when adolescents reported they disclosed to mothers and fathers and mothers and fathers solicited information from them, adolescents reported that both mothers and fathers knew more about their diabetes management. In addition, greater mean levels of disclosure and solicitation across the 14 days related

Table II MultiLevel Models of Solicitation and Daily Contact Predicting Disclosure From Diaries

Face-to-face interactions predicting disclosure	Coefficient	*SE*	Z	Odds ratio	OR LL	OR UL
Day	0.02	0.01	2.01*	1.02	1.00	1.04
Dad intercept	−1.89	0.10	−19.83**	0.15	0.13	0.18
Dad face-to-face within (L1)	0.15	0.02	6.35**	1.16	1.11	1.22
Dad face-to-face between (L2)	0.23	0.02	10.15**	1.26	1.21	1.32
Mom intercept	−1.09	0.05	−21.33**	0.33	0.30	0.37
Mom face-to-face within (L1)	0.07	0.02	3.65**	1.08	1.03	1.12
Mom face to-face between (L2)	0.17	0.02	9.66**	1.18	1.14	1.23
Nonface-to-face interactions predicting disclosure						
Day	0.02	0.01	2.07*	1.02	1.00	1.04
Dad intercept	−1.77	0.07	−25.55**	0.17	0.15	0.20
Dad nonface-to-face within (L1)	0.05	0.06	0.82	1.05	0.93	1.18
Dad nonface-to-face between (L2)	0.19	0.04	4.26**	1.21	1.11	1.31
Mom intercept	−1.05	0.05	−22.09**	0.35	0.32	0.38
Mom nonface-to-face within (L1)	0.03	0.02	1.60	1.03	0.99	1.06
Mom nonface-to-face between (L2)	0.10	0.02	4.68**	1.10	1.06	1.15
Solicitation predicting disclosure						
Day	0.03	0.01	2.41*	1.03	1.01	1.05
Dad intercept	−2.33	0.09	−24.81**	0.10	0.08	0.12
Dad solicitation within (L1)	2.03	0.20	10.09**	7.58	5.11	11.24
Dad solicitation between (L2)	4.04	0.21	18.97**	56.72	37.37	86.10
Mom intercept	−1.38	0.06	−22.59**	0.25	0.22	0.28
Mom solicitation within (L1)	1.29	0.14	9.33**	3.64	2.77	4.77
Mom solicitation between (L2)	3.80	0.17	22.53**	44.89	32.24	62.50

Note. $^{**}p < .01$; $^{*}p < .05$.

to overall mothers' and fathers' knowledge. Next, we examined whether disclosure and solicitation were associated with adolescents' perceptions of parental helpfulness on a daily basis. Both disclosure to and solicitation from mothers and fathers were associated with greater perceptions of parents' helpfulness on a within-person (daily) level and a between-person level.

Daily Disclosure and Regulation of Diabetes

Multilevel models were also conducted predicting daily diabetes management (self-regulation, adherence, and BG) from daily adolescent disclosure and parental solicitation (see Table III). For the dependent measure of self-regulation failures, on days when adolescents disclosed to their mothers, they reported fewer self-regulation failures. In addition, adolescents who reported greater disclosure to mothers across the 14 days also reported fewer self-regulation failures. No significant associations were found on self-regulation failures for solicitation from mothers either at the daily within-person or the between-person level. Similarly, no significant associations were found for either disclosure to, or solicitation from, fathers at either the within- or between-person level.

Similar analyses were conducted for daily adherence, with similar results. On days when adolescents disclosed to their mothers, they reported better adherence. No significant effects were found for disclosure to fathers nor for solicitation from either mothers or fathers.

A final analysis was conducted predicting daily BG mean, after controlling for duration of illness and pump status. Greater illness duration was associated with higher mean BG values. The only significant association was a between-person effect indicating that, across the 14 days, daily mean BG was lower when adolescents reported greater disclosure to mothers.

Discussion

Consistent with the broad developmental literature, our results indicated that daily adolescent disclosure and parent solicitation are part of a larger context of healthy parent–adolescent relationships (Hare et al., 2010; Racz & McMahon, 2011). Daily maternal solicitation occurred in the context of warm and accepting parent–child relationships. Both disclosure to and solicitation from mothers and fathers were associated with adolescents' greater perceptions of parents' knowledge about their diabetes management and with adolescents' perceptions of parents' helpfulness. Although research indicates that disclosure and solicitation tend to decrease across adolescence (Keijsers et al., 2010), the family context of disclosure,

Table III *Relations of Disclosure to Knowledge, Helpfulness, and Diabetes Management in Diary*

	Knowledge			Helpfulness					
Independent Variables	B	*SE*	*t*	B	*SE*	*T*			
Day	−0.01**	0.004	−2.87	−0.02**	0.01	−3.80			
Dad intercept	2.05**	0.029	71.04	2.25**	0.03	82.17			
Dad disclosure within (L1)	0.66**	0.066	9.92	0.63**	0.08	8.04			
Dad disclosure between (L2)	1.52**	0.165	9.17	1.48**	0.19	7.93			
Dad solicitation within (L1)	0.73**	0.078	9.29	0.74**	0.09	8.05			
Dad solicitation between (L2)	1.60**	0.117	13.67	1.41**	0.14	10.13			
Mom intercept	2.52**	0.022	115.62	2.71**	0.02	117.29			
Mom disclosure within (L1)	0.78**	0.056	13.87	0.69**	0.07	10.29			
Mom disclosure between (L2)	1.24**	0.136	9.06	1.20**	0.14	8.65			
Mom solicitation within (L1)	0.73**	0.078	9.29	0.68**	0.07	10.06			
Mom solicitation between (L2)	1.66**	0.113	14.65	1.49**	0.10	15.25			
	Self-Regulation Failures			Adherence			BG		
	B	*SE*	*t*	B	*SE*	*T*	B	*SE*	*t*
Intercept	16.73**	0.41	40.99	4.14**	0.05	91.72	194.43**	5.18	37.56
Day	−0.05*	0.02	−0.24	−0.001	0.002	−0.661	−.16	.29	−0.53
Dad disclosure within (L1)	−0.45	0.37	−1.22	0.02	0.04	0.67	−1.24	6.47	−.19
Dad disclosure between (L2)	1.04	2.85	0.36	−0.09	0.29	−0.3	1.24	25.01	0.05
Dad solicitation within (L1)	0.19	0.41	0.48	−0.001	0.06	−0.02	1.03	4.71	.22
Dad solicitation between (L2)	−0.81	2.52	−0.32	0.04	0.25	0.17	11.65	21.20	0.55
Mom disclosure within (L1)	−1.07**	0.29	−3.76	0.09*	0.03	2.69	−1.96	3.80	−.52
Mom disclosure between (L2)	−4.73*	2.18	−2.17	0.47	0.27	1.91	−58.20**	20.34	−2.86
Mom solicitation within (L1)	0.44	0.28	1.59	0.002	0.03	0.09	4.52	3.96	1.14
Mom solicitation between (L2)	−2.35	1.95	−1.20	0.006	0.221	0.025	11.18	18.62	.60
Pump							−12.41	7.70	−1.61
Years diagnosis							3.39**	1.01	3.34

Note. **$p < .01$; *$p < .05$.

solicitation, and knowledge was associated with better diabetes management even in late adolescence.

The daily processes of adolescent disclosure and parental solicitation revealed active roles of both adolescents and parents. On days when adolescents reported disclosing to parents, they also reported that their parents solicited information from them. It is important to note that in the present study the disclosure measure asked adolescents to indicate whether they disclosed to their parents about their diabetes without their parents asking them. Thus, parental solicitation and adolescent disclosure were distinct constructs, even though they co-occurred on a daily basis. The important role played by both adolescent disclosure and parent solicitation in contributing to parental knowledge is also found among adolescents without chronic illness (Solis et al., 2015). The present study contributes to the large body of literature on the importance of parental involvement for managing chronic illness by pointing to the active role of adolescents in disclosing to parents to facilitate such involvement.

The importance of face-to-face parent–adolescent contact in disclosure was evident in that adolescents disclosed more to their mothers and to their fathers on days when they had more face-to-face contact with parents, consistent with findings that adolescent disclosure occurs more frequently when families spend time together (Willoughby & Hamza, 2011). There was an overall association of nonface-to-face contact with disclosure to mothers and fathers across the 14 days, suggesting that, in general, nonface-to-face communication may maintain the connection for adolescent disclosure to occur. As late adolescence is a time when adolescents are less frequently in contact with parents, future research should examine how adolescents and their parents can engage to facilitate disclosure even when they no longer have daily contact. This will likely involve maintaining a warm and accepting relationship so that when emerging adults disclose they can expect support rather than conflict to occur (Tilton-Weaver, 2014).

The association of daily adolescent disclosure to mothers with fewer self-regulation failures and better adherence suggests that disclosure may be an important social regulatory mechanism through which adolescents gain assistance to avoid self-regulatory failures and maintain adherence (Lansing & Berg, 2014). This idea is supported by the daily positive association between adolescent disclosure and perceived helpfulness of parents. Our results demonstrated that adolescent daily disclosure had unique positive associations with diabetes management above and beyond daily parental solicitation (see also Keijsers et al., 2010 in broader developmental literature). In addition, daily disclosure had associations over and above the between-person effect of disclosure in general, suggesting the value of taking a daily approach to the examination of adherence. Such results may indicate the important role that adolescent disclosure to parents may play in initiating a process of garnering parents' assistance. Future work is needed that tracks this process throughout the day through Ecological Momentary Assessment (Shiffman, Stone, & Hufford, 2008) to ascertain whether disclosure elicits parents' help, thereby reducing self-regulatory failures and supporting adherence behaviors.

The potential benefits of adolescent disclosure for fewer self-regulatory failures and better treatment adherence were specific to disclosure to mothers. Mothers are often more involved in their adolescent's diabetes care (Berg et al., 2013), putting them "in the trenches" of diabetes management more often than fathers. Because they have more experience in managing their child's illness, mothers may have more effective solutions to the illness-related problems their adolescents disclose to them, leading to improved diabetes outcomes. Future research is needed to assess the clinical significance of the effects of disclosure, as such effects may be only one part of a larger system of factors involved in diabetes management during late adolescence (e.g., peer support and interference).

The contributions of the study must be interpreted in light of some limitations. First, data were collected via adolescents' daily self-reports. Although such reports predict adolescent behavior better than parents' reports (Racz & McMahon, 2011), they are still vulnerable to recall biases despite being completed each evening. Future studies could benefit by including additional methods (observational data of adolescent behaviors and interactions with parents, Ecological Momentary Assessment (EMA), and Electronically Activated Recorder). Second, BG reports may have been affected by participants having multiple meters with end of day reports not capturing some BG data (e.g., for individuals who had a separate meter at school). Third, the current study included a measure of only unsolicited adolescent disclosure, but disclosure could be either solicited or unsolicited. Future research should examine all aspects of parent–adolescent communication via methods that allow triangulation of reporters between multiple family members and multiple methods of data collection. Such measurement would allow for fine-grained accounts of the number of daily face-to-face and nonface-to-face contacts with parents and would address the temporal sequencing of daily processes of solicitation and disclosure. Fourth, our participation rate was somewhat lower than is typically reported with younger adolescents (Miller et al., 2012; Wiebe et al., 2014). Emerging adults are difficult to recruit, with individuals frequently skipping clinic appointments (where recruitment occurs) and being "too busy" in their senior year of high school to participate. Finally, the majority of the sample included Caucasians from

relatively well-educated families. It is notable, however, that Tasopoulos-Chan, Smetana, and Yau (2009) found no differences in frequency of disclosure or its associations with positive health outcomes across Mexican, Chinese, and European youth.

The present findings confirm a small, but growing, literature indicating that parental involvement in diabetes management remains important even in late adolescence, when youth are increasingly out of physical contact with parents and managing diabetes more independently (Monaghan, Helgeson, & Wiebe, 2015). It may be important for late adolescents and parents to receive the message that they may benefit from maintaining active information flow from adolescents to parents about diabetes, as they often receive messages from physicians to become independent from parents in managing diabetes. Even emerging adults benefit from the support of their parents (Monaghan et al., 2015), consistent with the benefit that support from close relationships such as romantic partners holds for diabetes management across adulthood (Wiebe et al., in press). Our findings raise questions about whether late adolescents will continue to disclose to parents as they transition out of the family home and have less contact with parents and whether other close relationships (e.g., friends and romantic partners) can be used as support providers in addition to parents (e.g., Helgeson et al., 2015). As late adolescence and emerging adulthood is a time when diabetes management is particularly poor (Monaghan et al., 2015), the findings enhance our understanding of how this at-risk population regulates their social environment to facilitate diabetes management.

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References

Berg, C. A., Butler, J. M., Osborn, P., King, G., Palmer, D. L., Butner, J. … & Wiebe, D. J. (2008). Role of parental monitoring in understanding the benefits of parental acceptance on adolescent adherence and metabolic control of type 1 diabetes. *Diabetes Care*, *31*, 678–683.

Berg, C. A., Butner, J. E., Butler, J. M., King, P. S., Hughes, A. E., & Wiebe, D. J. (2013). Parental persuasive strategies in the face of daily problems in adolescent type 1 diabetes management. *Health Psychology*, *32*, 719–728.

Berg, C. A., Wiebe, D. J., Suchy, Y., Hughes, A. E., Anderson, J. H., Godbey, E., … & White, P. C. (2014). Individual differences and daily fluctuation in perceived self-regulation associated with daily adherence in adolescents with type 1 diabetes. *Journal of Pediatric Psychology*, *39*, 1039–1048.

Ellis, D. A., Podolski, C. L., Frey, M., Naar-King, S., Wang, B., & Moltz, K. (2007). The role of parental monitoring in adolescent health outcomes: Impact on regimen adherence in youth with type 1 diabetes. *Journal of Pediatric Psychology*, *32*, 907–917.

Epstein, S. (1983). *The mother-father-peer scale*. Unpublished manuscript, University of Massachusetts, Amherst, MA.

Hare, A. L., Marston, E. G., & Allen, J. P. (2010). Maternal acceptance and adolescents' emotional communication: A longitudinal study. *Journal of Youth and Adolescence*, *40*, 744–751.

Helgeson, V. S., Mascatelli, K., Reynolds, K. A., Becker, D., Escobar, O., & Siminerio, L. (2015). Friendship and romantic relationships among emerging adults with and without type 1 diabetes. *Journal of Pediatric Psychology*, *40*, 359–372.

Helgeson, V. S., Palladino, D. K., Reynolds, K. A., Becker, D. J., Escobar, O., & Siminerio, L. (2014). Relationships and health among emerging adults with and without type 1 diabetes. *Health Psychology*, *33*, 1125–1133.

Hoffman, L., & Stawski, R. S. (2009). Persons as contexts: Evaluating between-person and within-person effects in longitudinal analyses. *Research in Human Development*, *6*, 97–120.

Hood, K. K., Peterson, C. M., Rohan, J. M., & Drotar, D. (2009). Association between adherence and glycemic control in pediatric type 1 diabetes: A meta-analysis. *Pediatrics*, *124*, e1171–e1179.

Keijsers, L., Branje, S. J., VanderValk, I. E., & Meeus, W. (2010). Reciprocal effects between parental solicitation, parental control, adolescent disclosure, and adolescent delinquency. *Journal of Research on Adolescence*, *20*, 88–113.

Keijsers, L., & Poulin, F. (2013). Developmental changes in parent-child communication throughout adolescence. *Developmental Psychology*, *49*, 2301–2308.

Kerr, M., Stattin, H., & Burk, W. J. (2010). A reinterpretation of parental monitoring in longitudinal perspective. *Journal of Research on Adolescence*, *20*, 39–64.

La Greca, A. M., Follansbee, D., & Skyler, J. S. (1990). Developmental and behavioral aspects of diabetes management in youngsters. *Children's Health Care*, *19*, 132–139.

Lansing, A. H., & Berg, C. A. (2014). Topical review: Adolescent self-regulation as a foundation for chronic illness self-management. *Journal of Pediatric Psychology*, *39*, 1091–1096.

Lewin, A. B., LaGreca, A. M., Geffken, G. R., Williams, L. B., Duke, D. C., Storch, E. A., & Silverstein, J. H. (2009). Validity and reliability of an adolescent and parent rating scale of type 1 diabetes adherence behaviors: The Self-Care Inventory (SCI). *Journal of Pediatric Psychology*, *34*, 999–1007.

Main, A., Wiebe, D. J., Bogart, K. V., Turner, S. L., Tucker, C., & Berg, C. A. (2015). Secrecy from parents and associations with type 1 diabetes management in late adolescence. *Journal of Pediatric Psychology*, *40*, 1075–1084.

Miller, M. M., Rohan, J. M., Delamater, A., Shroff-Pendley, J., Reeves, G., & Drotar, D. (2012). Changes in executive functioning and self-management in adolescents with type 1 diabetes: A growth curve analysis. *Journal of Pediatric Psychology*, *38*(1), 18–29.

Monaghan, M., Helgeson, V. S., & Wiebe, D. (2015). Type 1 diabetes in young adulthood. *Current Diabetes Reviews*, *11*, 239–250.

Muthén, L. K., & Muthén, B. O. (1998–2011). Mplus: Statistical analyses with latent variables. In *User's guide*. Los Angeles, CA: Muthén & Muthén.

Nansel, T. R., Rovner, A. J., Haynie, D., Iannotti, R. J., Simons-Morton, B., Wysocki, T., … & Laffel, L. (2009). Development and validation of the collaborative parent involvement scale for youths with type 1 diabetes. *Journal of Pediatric Psychology*, *34*, 30–40.

Osborn, P., Berg, C. A., Hughes, A. E., Pham, P., & Wiebe, D. J. (2013). What mom and dad don't know can hurt you: Adolescent disclosure to and secrecy from parents about type 1 diabetes. *Journal of Pediatric Psychology*, *38*, 141–150.

Racz, S. J., & McMahon, R. J. (2011). The relationship between parental knowledge and monitoring and child and adolescent conduct problems: A 10-year update. *Clinical Child and Family Psychology Review*, *14*, 377–398.

Raudenbush, S. W., Brennan, R. T., & Barnett, R. C. (1995). A multivariate hierarchical model for studying psychological change within married couples. *Journal of Family Psychology*, *9*, 161–174.

Seiffge-Krenke, I. (2002). "Come on, say something, Dad!": Communication and coping in fathers of diabetic adolescents. *Journal of Pediatric Psychology*, *27*, 439–450.

Shiffman, S., Stone, A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, *4*, 1–32.

Solis, M. V., Smetana, J. G., & Comer, J. (2015). Associations among solicitation, relationship quality, and adolescents' disclosure and secrecy with mothers and best friends. *Journal of Adolescence*, *43*, 193–205.

Stattin, H., & Kerr, M. (2000). Parental monitoring: A reinterpretation. *Child Development*, *71*, 1072–1085.

Tasopoulos-Chan, M., Smetana, J. G., & Yau, J. P. (2009). How much do I tell they? Strategies for managing information to parents among American adolescents from Chinese, Mexican, and European backgrounds. *Journal of Family Psychology*, *23*, 364–374.

Tilton-Weaver, L. (2014). Adolescents' information management: Comparing ideas about why adolescents disclose to or keep secrets from their parents. *Journal of Youth and Adolescence*, *43*, 803–813.

Waizenhofer, R. N., Buchanan, C. M., & Jackson-Newsom, J. (2004). Mothers' and fathers' knowledge of adolescents' daily activities: Its sources and its links with adolescent adjustment. *Journal of Family Psychology*, *18*, 348–360.

Wiebe, D. J., Chow, C. M., Palmer, D. L., Butner, J., Osborn, P., & Berg, C. A. (2014). Developmental factors associated with longitudinal declines in parental responsibility and adherence to type 1 diabetes management across adolescent. *Journal of Pediatric Psychology*, *39*, 532–541.

Wiebe, D. J., Helgeson, V. S. I., & Berg, C. A. (in press). The Social context of managing diabetes across life span. American Psychologist.

Willoughby, T., & Hamza, C. A. (2011). A longitudinal examination of the bidirectional associations among perceived parenting behaviors, adolescent disclosure and problem behavior across the high school years. *Journal of Youth and Adolescence*, *40*, 463–478.